

PART 00900 - PERMANENT TRAFFIC CONTROL AND ILLUMINATION SYSTEMS

Section 00905 - Removal and Reinstallation of Existing Signs

Description

00905.00 Scope - This work consists of one or both of the following:

- Removing existing signs, specific service signs and tourist-oriented directional signs (TODS) as shown or directed.
- Removing and moving existing signs, specific service signs and tourist-oriented directional signs (TODS) from their existing locations and reinstalling them at new locations as shown or directed.

Construction

00905.40 General - Do not remove signs from existing supports until new supports are in place, ready to receive the signs. Install the signs on the new supports immediately after removing from existing supports. Provide temporary supports as required. Provide permanent supports according to Sections 00920, and 00930 as required.

Protect specific service signs (business logos) and TODS from damage, whether the signs are to remain in place or are placed on temporary supports, until reinstalled on permanent supports. Repair or replace damaged signs at no cost to the City. Liquidated damages will be assessed against the Contractor in the amount of \$200 per day for each sign out of service for more than five calendar days.

Install rigid, temporary vertical ties to the back of all extruded aluminum panel signs to prevent buckling of the sign panels and/or their legends during removal, moving and reinstallation of the signs. Repair any damage inflicted to the signs or their legends.

Remove to 1 foot below the ground line those installations with concrete or steel footings set in the ground unless indicated otherwise. Fill the resultant hole and finish the surface to correspond with the surrounding area. Do not remove the existing appurtenances until ordered. Dispose of all existing appurtenances removed and not used in reinstallation, according to 00310.43.

Measurement

00905.80 Lump Sum Basis - No measurement of quantities will be made for this work.

Payment

00905.90 General - Removing existing signs will be paid for at the Contract lump sum amount for the item "Remove Existing Signs". Removing, moving and reinstalling existing signs will be paid for at the Contract lump sum amount for the item "Remove and Reinstall Existing Signs". Payment will be payment in full for all Materials, Equipment, labor and Incidentals necessary to complete the work as specified.

Section 00920 - Sign Support Footings

Description

00920.00 Scope - This work consists of constructing sign support footings of the dimensions and design shown and at the locations shown or directed. Sign support footings include foundations for overhead sign supports and roadside sign supports.

Materials

00920.10 General - Materials for constructing sign support footings shall meet the following requirements:

Anchor bolts.....	02560.30
Backfill (unless otherwise directed)	00510.10 or .11
Commercial Grade Concrete	00440
Conduit	02920.10 -.12
Reinforcement	00530

00920.11 Breakaway Footings - Provide 2-inch diameter schedule 40 pipe post breakaway footings complying with NCHRP350 testing and have a "WZ" letter of approval from Federal Highway Administration such as Sign Support Systems at P.O. Box 8041, Greensboro, North Carolina, 27419, 1-866-549-7706, Part No. BOR 238-1012 or approved equal.

Construction

00920.40 Excavation and Backfill - Excavate and backfill footings according to Section 00510.

Finish the surface of backfill to match the existing surface. Where required, reinstall curbs and asphaltic markers.

00920.41 Concrete - Construct concrete sign foundations according to Section 00440.

Pour concrete spread footings and concrete shaft footings against undisturbed material or backfill with selected granular backfill material according to 00510.11. Compact to 95% maximum density according to 00330.43 or as shown.

During concrete placement, accurately and securely hold in place all anchor bolts, post stubs or [breakaway footings](#) until the concrete has set.

00920.42 Reinforcement - Fabricate and place steel reinforcement according to Section 00530.

00920.43 Conduit - Fabricate and install conduit according to Sections 00970 and 00990.

00920.44 Breakaway Footing Placement - Place breakaway footings so that when the pipe posts are inserted into the breakaway footing, the posts will be plumb with no more variance than a 1/4 inch in 12 feet.

Measurement

00920.80 Lump Sum Basis - No measurement of quantities will be made for work under this Section unless plan changes are ordered.

The estimated quantity of concrete required to complete the footings and pedestals will be listed in the Special Provisions for the purpose of providing a basis for adjustment if changes in the work are ordered. No adjustment in the Contract lump sum amount will be made except as provided above. Any adjustment in the Contract lump sum amount will be made according to 00190.10(f).

Payment

00920.90 General - Payment will be made at the Contract lump sum amount for the following items:

	Pay Item	Unit of Measurement
(a)	Sign Support Footings.....	Lump Sum
(b)	Sign Support Footings, Breakaway	Lump Sum

Item (b) is for breakaway footings conforming to 00920.11.

Payment, plus or minus adjustments if any, will be payment in full for excavation, backfill, shoring, reinforcement, anchor bolts, conduit, and all materials, equipment, labor and incidentals necessary to complete the work as specified.

Section 00930 - Metal Sign Supports

Description

00930.00 Scope - This work consists of furnishing, fabricating, galvanizing and erecting metal sign supports, including sign bridges and sign structures.

00930.01 Definitions and Terms:

(a) Multi-Post Breakaway Sign Supports - The complete structure is composed of post stubs, base plates, posts, hinges, sign support members, and fastenings, but does not include the sign support footings.

(b) Pipe Sign Posts, Special Pipe Sign Supports, Square Tube Sign Supports, Single Post Breakaway Sign Supports, Triangular Base Breakaway Sign Supports and Offset Single Sign Supports - The complete structure is composed of post stub, base plates, metal post, sign support members, and fasteners, but does not include the sign support footings.

(c) Sign Bridge, Ell Sign Bridge, Butterfly Sign Structure and Cantilever Sign Structure - The complete structure is composed of base plates, support columns, cantilever arms, trusses, sign support arms, supporting brackets, and fasteners, but does not include the sign illumination equipment, maintenance walkways and sign support footings.

(d) Double Sign Support and Triple Sign Support - The complete structure is composed of post stub, base plate, pipe support column, sign frames, and supporting brackets, but does not include the sign support footing.

(e) Structure Mount - The I-beam or special detailed attachments used for mounting signs to bridge structures, and includes all necessary support brackets and arms, and fasteners, but does not include sign illumination equipment and maintenance walkways.

(f) Exit Number Sign Supports - The I-beams, spacers, special mounting brackets, and fasteners, necessary to install the exit number signs.

(g) Sign and Luminaire Supports and Signal Pole Mounts - The complete support including horizontal and vertical arms, supporting brackets, and fasteners.

(h) Route Marker Frames - The channel frame used to mount two or more route shield assemblies to a single support.

(i) Special Sign Bracket - The bracket used to mount two or more signs on a single support when all signs are not parallel or at right angle to the others.

(j) Maintenance Walkways - The complete structure is composed of safety rails and posts, horizontal and vertical walkway support arms (except sign support arms), grating, post brackets, supporting brackets, and fasteners, but does not include sign illumination equipment.

00930.02 Working Drawings - Submit six copies of stamped working drawings, plans, details, and calculations according to 00150.35(m)(1) for all structural metal work. Any material ordered or work done before the review of working drawings shall be at the Contractor's risk. All engineered details and drawings that are not prepared by the City but are required in the Contract Documents and Specifications for the Project shall be submitted for review prior to fabrication.

In addition to the working drawings, submit six copies of all available data including manufacturer's pamphlets and brochures, technical bulletins, working drawings and other technical information relative to products used on the Project. After installation, submit corrected working drawings that represent the material as installed and in operation. Include sufficient information to enable the City's maintenance forces to replace all or part of the commercially manufactured sign structures, under routine or emergency maintenance, by direct reference to the information furnished by the Contractor.

Working drawings are not required for the following types of steel supports:

- Single Post Breakaway Sign Supports
- Triangular Base Breakaway Sign Supports
- Multi-Post Breakaway Sign Supports
- Signal Pole Mounts

Working drawings for these supports will be provided by the Engineer of Record. Use the Field Verification of Post Lengths form, available from the Engineer, to provide necessary site data to the Engineer of Record for use in producing working drawings. Any work done, or materials ordered, prior to receiving working drawings from the Engineer of Record will be at the Contractor's expense.

00930.03 Commercially Manufactured Products - Instead of fabricating "Sign Structures" as shown, the Contractor may offer for consideration and approval, as a substitution, a standard manufactured product of aluminum or steel. Submit stamped engineered details and drawings for manufactured products according to 00150.35(m)(1).

If commercially manufactured sign structures are furnished, they shall be designed for the ultimate sign size and wind pressure given on the plans and meet the requirements of the current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals".

Furnish complete, proposed material specifications and fabrication criteria with the working drawings.

00930.09 Identifying Tags - Overhead sign support structures, except structure mounts, shall have stainless steel or brass identifying tags attached to all posts, arms, and truss sections. The tags shall be at least 1/16 inch thick. Tag lettering shall be at least 1/4 inch in height, and shall be stamped into the tag. Tags shall be attached with stainless steel pop rivets of at least 3/16 inch nominal body diameter. Do not locate pop rivet holes within 6 inches of welds. Post tag shall be located approximately 5 feet above the baseplate. Holes for pop rivets shall be drilled prior to hot-dip galvanizing. Remove excess hot-dip galvanizing from holes and repair according to ASTM A780.

Tags shall include the following information:

- Structure number
- Manufacturer
- Month and year of manufacture

Materials

00930.10 General - Provide structural steel materials and pipe sign posts conforming to the applicable portions of Section 02530, with weights and sizes as shown or specified.

Provide galvanized bolts, nuts, hardened washers, and direct tension indicators conforming to Section 02560, except the Rotational Capacity Test of 02560.60(a) need not be repeated at the job site.

All components of steel sign structures shall be galvanized after fabrication and before assembly. Galvanizing shall conform to the requirements of Section 02530.

Labor

00930.30 Fabricators - Fabricators of metal sign supports shall have either a current AISC Simple Steel Bridge Structures (Sbr) certification or a current AISC Major Steel Bridges (Cbr) certification.

Construction

00930.40 Fabrication and Erection - Fabricate and erect according to the applicable portions of Section 00560, except where in conflict with the following:

(a) General - Erect breakaway sign posts, pipe sign posts and pipe support columns at a true vertical.

Where two or more posts are required to support a sign, orient and position both posts so that no twist or warp will be imparted to the sign panels.

(b) Assembly of Metal - Accurately assemble the parts as shown on the plans and follow any match marks. Handle the material carefully so that no parts will be bent, broken or otherwise damaged. Clean bearing surfaces and surfaces to be in permanent contact before the members are assembled. Roughen faying surfaces of slip-critical structural connections utilizing high strength bolts by means of hand wire brushing after galvanizing. Power wire brushing is not permitted.

(c) Welding - Weld steel sign structures according to AWS D1.1. The fabricator shall inspect welds in accordance with details and requirements called out on the Contract Documents. This requirement will override all appropriate weld inspection requirements called out in Section 1.4.2 WELDING OF STEEL STRUCTURES in AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals". Submit all testing procedures for Engineer's review prior to starting inspection. Submit certified copies of inspection reports to the Engineer for review.

If requested by the Engineer, additional weld inspection may be required upon arrival of the material at the job site. If defects are found by this additional inspection, the Contractor shall be responsible for the additional testing and repair costs. If no defects are found, the Engineer will be responsible for the additional inspection costs.

(d) Bolt Installation - Do not reuse galvanized high strength bolts. Other high strength bolts may be reused, if approved, but not more than once. Retightening previously tightened bolts that may have been loosened by the tightening of adjacent bolts will not be considered a reuse.

Provide all high strength bolts with hardened washers under the element (nut or bolt head) turned in tightening. If a high strength bolt is installed in an oversize or short slotted hole in an outer ply, use a hardened washer. If a high strength bolt is installed in a long slotted hole in an outer ply, use a plate washer or a continuous bar made of structural grade steel at least 5/16 inch thick with standard holes. Make the washer or bar sufficiently large to completely cover the slot after installation.

Protect fasteners from dirt and moisture at the jobsite. Do not remove the lubricant that is present in as-delivered condition. Lubricated fasteners that accumulate dirt shall be cleaned and relubricated according to 02560.70.

(1) Bolt Installation for Slip Bases (Breakaway) - Furnish, at no additional compensation, a calibrated torque wrench of a capacity appropriate to the size of the high-strength bolts installed and tightened. Confirm the accuracy of the calibrated torque wrench through calibration by an approved testing agency at least once a year. Remove any dirt and moisture from the lubricated fasteners, and recoat the lubricated fasteners with a fresh, second coat of lubricant immediately before tightening. Tighten the bolts, in the presence of the Engineer, to the minimum torque or tension shown to seat the bolts in the base plate slots. After all the bolts in the slip base are tightened, loosen each bolt and retighten to the prescribed torque or tension shown in the same order as the initial tightening.

(2) Bolt Installation for Slip-Critical Connections - Tighten high strength bolts by direct tension indicator method unless noted otherwise.

a. Direct Tension Indicator Tightening - Install new and unused direct tension indicator washers that meet the requirements of 02560.20(d) and 02560.40(b) at each bolt. Do not permit the surfaces contacting the protrusions of the direct tension indicator washers to turn during tightening. Bring each bolt to a snug tight condition, as indicated by partial compression of the direct tension indicator protrusions. Then tighten all fasteners in the connection, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening before final tightening to deform the protrusion to nil gap or as specified.

A nil gap is defined as the condition that exists when at least half of the spaces between the direct tension indicator protrusions refuse entry to a 0.005 inch feeler gage, and a visible gap exists in at least one space.

b. Turn-of-Nut Tightening - During all turn-of-nut tightening, proceed systematically from the most rigid part of the connection to the free edges. Tighten all bolts until they are simultaneously snug tight and the connection is fully compacted. Snug tight is defined as the tightness that exists when all plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a worker using a 12 inch long wrench. Following this initial operation, further tighten all bolts in the connection by the amount of rotation specified in Table 00560-2 of Section 00560. During the tightening operation do not permit rotation of the part not turned by the wrench.

(e) Bolt Inspection:

(1) General - The Engineer will observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and that all bolts are tightened, and in the case of direct tension indicators that the correct indication of tension has been achieved. Bolts may reach tensions substantially above the value given in Table 00560-1 in Section 00560, but this will not be cause for rejection.

(2) Direct Tension Indicator Method - Provide the Engineer full opportunity to witness installation of bolted connections. The Engineer will periodically observe the installation and tightening operations to ensure that proper procedures are being adhered to.

Upon completion of a bolted joint, the Engineer will determine that all bolts have been tightened. A minimum of 10%, but not less than two bolts in each joint, will be inspected. If all gaps checked are nil or as shown, the joint will be accepted as properly tightened. If gaps checked are in excess of the above, reinspect all bolts and retighten bolts in the joint, as required, then resubmit the joint for inspection.

Apply the feeler gauge to all of the openings between protrusions around the indicator circumference. To satisfy the nil gap requirement, the feeler gauge shall be refused by at least one-half of the applied places.

(3) Turn-of-Nut Method - When all turn-of-nut tightening activities have been witnessed and found acceptable by the inspector, no additional bolt tightening inspection is required. If turn-of-nut tightening has been performed without being witnessed by the inspector, the following inspection procedure shall be used:

- In the presence of the Engineer, use an inspection wrench, which may be a calibrated torque wrench.
- Place three bolts of the same grade, diameter and condition as those under inspection individually in a calibration device capable of indicating bolt tension. Use a hardened washer under the part turned in tightening each bolt.
- Tighten each bolt specified in the paragraph above in the calibration device by any convenient means to an initial condition equal to 20% of the required tension, and then to a tension not less than 5% greater than specified for its size in Table 00560-1 in Section 00560. Tightening beyond the initial condition must not produce greater nut rotation than 1.5 times that permitted in Table 00560-3 in Section 00560. Then apply the inspecting wrench to the tightened bolt and determine the torque necessary to turn the nut or head 5°, approximately 1 inch at 12 inches radius, in the tightening direction. Take the average torque measured in the tests of three bolts as the job inspecting torque to be used in the manner specified in the next paragraph.
- Test bolts that have been tightened in the structure and are represented by the sample prescribed above with the inspecting wrench. Apply the job inspecting torque to 10% of the bolts, but not less than two bolts selected at random. If no nut or bolt head is turned by this application of the job inspecting torque, the connection will be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, test all bolts in the connections. Retighten all bolts whose nut or head is turned by the job inspecting torque, and re-inspect. Retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.

00930.41 Adjustable Sign Mounts - Furnish and install a bracket that is adjustable horizontally and vertically to facilitate signal pole mast arm and pole mounting of flat sign sheets. The mount shall allow vertical adjustment for positioning the sign and shall rotate to plumb the sign. Construct the bracket from cast aluminum and galvanized steel elements that attach to the signal pole mast arm or other support with stainless steel straps. Use galvanized or stainless steel nuts, bolts and washers for fasteners.

Measurement

00930.80 Lump Sum Basis - No measurement of quantities will be made for metal sign supports unless plan changes are ordered or the field-verified post length increases or decreases by more than 25% of the length specified.

The estimated quantities of structural steel for an item will be listed in the Special Provisions for the purpose of providing a basis for adjustment. No adjustment in the lump sum Contract amount will be made, except as provided above. Any adjustment in the lump sum Contract amount will be made according to 00190.10(f).

00930.81 Unit Basis - Measurement of adjustable sign mounts will be on a unit basis, per each, by actual count of adjustable sign mounts installed and accepted.

Payment

00930.90 Lump Sum Basis - Payment will be made at the Contract lump sum amount for the following items, unless this price is adjusted according to 00930.80:

Pay Item	Unit of Measurement
Bridges	
(a) Sign Bridge	Lump Sum
(b) Ell Sign Bridge	Lump Sum
Structures	
(c) Butterfly Sign Structures	Lump Sum
(d) Cantilever Sign Structures	Lump Sum
Mounts	
(e) Structure Mounts	Lump Sum
(f) Signal Pole Mounts	Lump Sum
Posts	
(g) Pipe Sign Posts	Lump Sum
Supports	
(h) Multi-Post Breakaway Sign Supports	Lump Sum
(i) Special Pipe Sign Supports	Lump Sum
(j) Single Post Breakaway Sign Supports	Lump Sum
(k) Triangular Base Breakaway Sign Supports	Lump Sum
(l) Offset Single Sign Supports	Lump Sum
(m) Double Sign Supports	Lump Sum
(n) Triple Sign Supports	Lump Sum
(o) Exit Number Sign Supports	Lump Sum
(p) Sign and Luminaire Supports	Lump Sum
(q) Mast Arm Sign Supports	Lump Sum
(r) Square Tube Sign Supports	Lump Sum
(s) Square Tube Sign Supports W/TBB	Lump Sum

Walkways

(t) Maintenance Walkways Lump Sum

Item (t) includes support arms as specified except where sign support arms perform the dual purpose of supporting walkways and signs. Payment for the dual purpose sign support arms will be included in payment for the sign structure.

No separate payment will be made for route marker frames, wind bracing, pole clamps, stainless steel clamps, or special sign brackets. Payment will be included in payment made for one or more of the listed pay items.

Payment, plus or minus adjustments if any, will be payment in full for furnishing and placing all materials and furnishing all equipment, labor and Incidentals necessary to complete the work as specified.

00930.91 Unit Basis - Payment for accepted quantities of adjustable sign mounts will be at the Contract unit price per each for the pay item "Adjustable Sign Mounts". Payment will be payment in full for furnishing, attaching and adjusting the mounts and includes equipment, labor and Incidentals necessary to complete the work.

Section 00940 - Signs

Description

00940.00 Scope - This work consists of furnishing, fabricating and erecting traffic signs of the types shown.

00940.01 Sign Backgrounds - Use either reflectorized or nonreflectorized sign backgrounds as shown and according to 00940.02. [The use of baked enamel will not be allowed.](#)

(a) Color - Use sign background colors conforming to the Federal Highway Administration "Color Specifications for Retroreflective Sign and Pavement Marking Materials". Non-reflective, reflective, and retroreflective sheeting shall conform to Section 02910.

In addition, specified color coordinates shall be subject to visual matching by the Engineer to determine that all panels in any one sign match.

00940.02 Types of Signs - Traffic signs are classified by sign type as follows:

"B" Blue Type III or Type IV sheeting background with silver-white Type III or Type IV permanent or removable legend, or silver-white Type III or Type IV sheeting overlaid with blue transparent past background, with retroreflective silver-white screened legend on extruded aluminum panels, sheet aluminum, or plywood.

"B1" Blue Type I enclosed lens reflective sheeting background with silver-white Type III or Type IV permanent or removable legend with retroreflective silver-white screened legend on extruded aluminum panels, sheet aluminum, or plywood.

"B2" Blue Type III or Type IV sheeting background with white Type VII or Type IX permanent or removable legend on extruded aluminum panels or sheet aluminum.

"B3" Blue Type IX sheeting background with white Type VII or Type IX permanent or removable legend on extruded aluminum panels or sheet aluminum.

"C" Brown Type III or Type IV sheeting background with silver-white Type III or Type IV permanent or removable legend, or silver-white Type III or IV sheeting overlaid with brown transparent paste background, with retroreflective silver-white screened legend on extruded aluminum panels, sheet aluminum, or plywood.

"C1" Brown Type III or IV sheeting background with white Type VII or Type IX permanent or removable legend on extruded aluminum panels or sheet aluminum.

"C2" Brown Type IX sheeting background with the white Type VII or Type IX permanent or removable legend or white Type IX sheeting overlaid with brown transparent paste background, with retroreflective silver-white screened legend on extruded aluminum panels or sheet aluminum.

"C3" [Brown prismatic lens retroreflective sheeting on extruded aluminum panels, with white prismatic lens retroreflective removable legend.](#)

"F" Silver-white Type III or Type IV sheeting background overlaid with red and blue transparent paste background, with retroreflective silver-white screened legend or silver-white Type III or Type IV permanent legend on sheet aluminum or plywood.

"F1" White Type IX sheeting background overlaid with red and blue transparent paste background with white Type VII or Type IX permanent legend on sheet aluminum.

"G" Green Type III or Type IV sheeting background with silver-white Type III or Type IV permanent or removable legend, or silver-white Type III or Type IV sheeting background overlaid with green transparent paste background with retroreflective silver-white screened legend on extruded aluminum panels, sheet aluminum, or plywood.

"G1" Green Type III or Type IV sheeting background with white Type VII or Type IX removable legend on extruded aluminum panels.

"G2" Green Type III or Type IV sheeting background with white Type VII or Type IX permanent legend on sheet aluminum.

"G3" Green Type IX sheeting background with white Type VII or Type IX permanent legend, or white IX sheeting background overlaid with green transparent paste background with retroreflective silver-white screened legend on sheet aluminum.

"G4" Green Type IX sheeting background with white Type VII or Type IX removable legend on extruded aluminum panels.

"G5" Green encapsulated lens retroreflective sheeting background with white prismatic lens retroreflective permanent legend, or white prismatic lens retroreflective sheeting background overlaid with green transparent paste background with white retroreflective screened legend with a screened red transparent paste rose on sheet aluminum. (Street Name Sign)

"O" Orange Type I sheeting background with black nonreflective permanent or removable legend on extruded aluminum panels, sheet aluminum, or plywood.

"OO" Orange Type III or Type IV sheeting background with black nonreflective legend on extruded aluminum panels, sheet aluminum, or plywood.

"O3" Orange Type III or Type IV sheeting background with black nonreflective permanent legend and red retroreflective symbol on sheet aluminum or plywood. (Stop or Yield Ahead Symbol Sign)

"O4" Fluorescent orange Type VII, Type VIII, Type IX or Type X sheeting background with black nonreflective removable legend on extruded aluminum panels.

"O5" Fluorescent orange Type VII, Type VIII, Type IX or Type X sheeting background with black nonreflective removable legend on extruded aluminum panels.

"R" Silver-white Type III or Type IV sheeting background overlaid with red transparent paste background with silver-white Type III or Type IV permanent legend on sheet aluminum or plywood. (Stop Sign, Wrong-Way, Do Not Enter, etc.)

"R1" White Type IX sheeting background overlaid with red transparent paste background with white Type VII or Type IX permanent legend on sheet aluminum or plywood.

"R2" Silver-white Type III or Type IV sheeting background overlaid with screened red transparent paste triangle and legend or red Type III or Type IV triangle and permanent legend on sheet aluminum or plywood. (Yield Sign)

"R3" White Type IX sheeting background overlaid with screened red transparent paste triangle and permanent legend on sheet aluminum or plywood.

"R4" Rubber STOP flap made of natural rubber with a red background and white lettering.

"W1" Silver-white Type III or Type IV sheeting background with black screened, cut-out permanent, or removable legend on extruded aluminum panels, sheet aluminum, or plywood.

"W2" Silver-white Type III or Type IV sheeting background with a screened nonreflective black legend overlaid with red transparent paste circle and continuous diagonal bar on sheet aluminum or plywood. (Prohibition)

"W3" Silver-white Type III or Type IV sheeting background with transparent brown screened legend or brown Type III or Type IV Type III or IV cut-out permanent legend on sheet aluminum or plywood.

"W4" Silver-white Type III or Type IV sheeting background with transparent red screened legend or red Type III or Type IV cut-out permanent legend on sheet aluminum or plywood.

"W5" Silver-white Type III or Type IV sheeting with green transparent screened legend or green Type III or Type IV cut-out permanent legend on sheet aluminum or plywood.

"W6" White Type IX sheeting background with a screened or cut-out black nonreflective legend overlaid with a screened red transparent paste circle and continuous diagonal bar on sheet aluminum. (Prohibition Sign Overhead).

"W7" White Type IX sheeting background with black nonreflective screened cut-out permanent legend on sheet aluminum.

"W8" Silver-white Type III or Type IV sheeting background with blue transparent screened legend or blue Type III or Type IV cut-out permanent legend on sheet aluminum or plywood.

"W9" Silver-white Type III or Type IV sheeting background with fluorescent orange Type IX border and OTIA logo permanent legend. Lower legend is black nonreflective screened or cut-out permanent legend.

"W10" White Type IX sheeting background with black nonreflective removable legend on extruded aluminum panels.

"W11" Silver-white Type III or Type IV sheeting background with black nonreflective screened or cut-out permanent legend with red Type III or Type IV symbol on sheet aluminum or plywood. (Bicycle Stop or Bicycle Yield Symbol Signs)

"W12" Silver-white encapsulated lens retroreflective sheeting background on sheet aluminum or plywood, with a screened nonreflective black legend and a retroreflective circle and continuous diagonal bar overlaid with green transparent paste. (No Parking Sign)

"Y1" Yellow Type III or Type IV sheeting background with black nonreflective screened, cut-out permanent, or removable legend on extruded aluminum panels, sheet aluminum, or plywood.

"Y2" Yellow Type III or Type IV sheeting background with a screened or cut-out black nonreflective legend and red and green Type III or Type IV circles on sheet aluminum or plywood. The center yellow circle shall be part of the background sheeting. (Signal Ahead Symbol Sign)

"Y3" Yellow Type IX sheeting background with black nonreflective screened, cut-out permanent or removable legend on extruded aluminum panels or sheet aluminum.

"Y4" Yellow Type III or Type IV sheeting background with black nonreflective screened or cut-out permanent legend and red Type III or Type IV symbol on sheet aluminum or plywood. (Stop or Yield Ahead Symbol Sign)

"Y5" Fluorescent yellow Type IX sheeting background with black nonreflective screened, or cut-out permanent or removable legend. on extruded aluminum panels or sheet aluminum

"Y6" Fluorescent yellow IX sheeting background with black nonreflective screened or cut-out permanent legend and red and green Type IX circles on sheet aluminum. The center yellow circle shall be part of the background sheeting. (Signal Ahead Symbol Sign Overhead)

"Y7" Fluorescent yellow IX sheeting background with black nonreflective screened or cut-out permanent legend and red Type VII or Type IX circle on sheet aluminum. The center yellow circle shall be part of the background sheeting. (Stop or Yield Ahead Symbol Sign)

"Y8" Yellow Type III or Type IV sheeting background with black nonreflective screened or cut-out permanent legend and silver-white Type III or Type IV symbol on sheet aluminum or plywood. (Speed Reduction Symbol Sign)

"YG" Fluorescent yellow-green Type IX sheeting background with black nonreflective screened or cut-out permanent legend on sheet aluminum.

"YGW" Fluorescent yellow-green Type IX sheeting background with black nonreflective screened or cut-out permanent legend and silver-white Type III or Type IV symbol with black nonreflective screened or cut-out permanent legend and red Type III or Type IV symbol on sheet aluminum. (In-Street Pedestrian Crossing Symbol Sign)

00940.03 Drawings - Copies of working drawings for non-standard signs will be made available to the Contractor by the Engineer. Standard signs called for in the Contract Documents shall be constructed using drawings available in FHWA's "Standard Highway Signs" (FHWA English Version) or ODOT's "Sign Policy and Guidelines for the State Highway System" [or City of Portland Standard Drawings](#).

00940.04 Construction - Signs shall be fabricated of matched components from the same supplier, to ensure that all components of each sign are compatible, and are warrantable by the manufacturer. The removable legend does not have to be fabricated with sheeting from the same supplier as the background sheeting on the sign panels.

Materials

00940.10 General - Materials for signs shall conform to Section 02910. The use of reinforced sheet aluminum signs is not allowed [unless otherwise shown or specified](#).

00940.11 Alternate Materials - [The use of plywood as an alternate material, except for temporary signs, will not be allowed on the Project.](#)

In cases where the Contractor utilizes a standard manufactured item in the construction of signs, do not permit the mixing of items from more than one manufacturer unless otherwise shown or specified.

Construction

00940.40 General - Finished signs shall conform to the designs shown or specified.

Choose the substrate material from the following table:

Sign Size	Acceptable Substrate Materials
Up to 4' x 5'	Sheet aluminum Extruded aluminum panels
From 4' x 5' to 4' x 8'	Extruded aluminum panels
Over 4' x 8'	Extruded aluminum panels
Over 8' in any dimension	Extruded aluminum panels

See Table 02910-1 in Section 2910 for sheet aluminum thicknesses for various sizes of signs.

Construct standard signs as shown in the FHWA "Standard Highway Signs" manual or in the metric or English version (as appropriate) of ODOT's "Sign Policy and Guidelines for the State Highway System". The latter are available for purchase from the ODOT Traffic Management Section, Transportation Building, Salem.

00940.42 Sheet Aluminum Sign Fabrication:

(a) General - Cut the sheet aluminum sign to size and shape as shown or specified. The sign shall be free of buckles, warps, dents, cockles, burrs and defects resulting from fabrication.

Before application of reflective or nonreflective sheeting, treat the entire surface of the sign with a conversion film according to the sheeting manufacturer's recommendations.

(b) Mounting Holes:

(1) On Posts - Signs having a vertical dimension of less than 48 inches and mounted on wood or metal posts shall have at least two mounting holes. Signs having a vertical dimension of 48 inches or greater shall have three mounting holes. Place the third mounting hole near the center of the sign. Locate mounting holes so the mounting hardware will not cover any portion of the legend unless otherwise shown.

00940.45 Legend Installation:

(a) General - The word "legend" means the entire message and border for a sign. A group of words, numbers and/or symbols constitute the "message" for a sign. Install the type of legend for each traffic sign as shown and according to 00940.02.

Spacing between letters and/or numbers shall conform to the FHWA "Standard Alphabets for Highway Signs" manual.

Spacing between words for Series "E" (modified) legend shall be 1.5 times the upper case letter height. Spacing between words for other fonts shall be as tabulated below unless otherwise shown:

Legend	Series Word Spacing
B	(0.531) H
C	(0.625) H
D	(0.836) H
E	(0.836) H

Where H = height of upper case letter

Spacing between symbols shall conform to FHWA "Standard Highway Signs" unless otherwise shown.

Space all lines equally between side borders unless otherwise shown. Space the legend vertically as shown. For diamond shaped signs, space between lines in the legend a minimum of one half the average letter height and space between the message and the borders equally so the message is centered on the sign.

(b) Attachment - Apply screened legend according to the sheeting manufacturer's recommendations. Apply cut-out legend according to 00940.44.

(c) Border Sizes - Unless otherwise shown, the width of the sign borders shall be according to the following:

Maximum Letter Size	Border Width
5" Capital or Upper Case	1/2"
8" or 10 2/3" Upper Case	1"
10" or 12" Capital	1"
13 1/3" or 16" Upper Case	2"
15" or 16" Capital	2"

The corner radii shall be approximately one-eighth of the least dimension of the sign. The corner radii shall be determined by rounding this approximate value to the nearest of the following values:

1 1/2 inches, 3 inches, 6 inches, 9 inches or 12 inches

Except for the corners, mount the border flush with the edge of the sign. Do not round the corners of the aluminum panels.

(d) Overhead Street Name Sign (OSN) - The overhead street names signs shall consist of the standard guide sign with a green background and white letters. Refer to City Standard Drawing D-426. The sign shall be fabricated on white prismatic lens reflective sheeting ASTM Type IX on 0.125" thick aluminum sheeting. The sign shall utilize a reverse cut green translucent background (3M-1177 Electro-cut film or equivalent). The sign face shall display the City rose logo followed by the sign legend, which consists of the street name, prefix, street name (primary copy), primary copy suffix, and street name suffix as described below.

The length of the message will be dependent upon the name length plus the prefix, suffix and City's "Rose" logo as required, in multiples of six inches. The OSN sign shall have an overall length of not more than 84 inches and shall be not less than 36 inches. The sign faces shall be 12 inches in height, except the sign height shall be increased to 22 inches when two copy lines are required. No border is to be applied to the sign.

Legends shall be upper case in standard lengths and shall be fabricated using standard FHWA Series "C" letters for all primary copy, except "B" series may be used for the primary copy when the maximum length of the sign would otherwise be violated. When this occurs, the Engineer shall be notified to determine and approve an alternative design.

The primary copy (name message) letters shall be 8 inches upper case. The prefix and suffix, where required, shall be 6 inches upper case lettering.

The charts for Standard Alphabets for Highway Signs, Edition 1977, shall be used. The direction prefix (one or two letters) will be upper case, 6 inches in height and centered on the primary copy capital letters. The suffix of the primary copy shall be uppercase superscript and shall be 4 inches in height. The suffix copy shall be all caps and shall be 6 inches in height and aligned in line with the bottom of the primary copy's capital letters. See illustration for placement of the prefix, main copy, copy suffix and suffix.

Street Name Signs shall have a single message on one face only. Two lines of copy shall not be used.

The City's "Rose" logo shall be placed on the left side of the sign face, vertically centered on the sign face. The City "Rose" logo design shall be obtained from the City of Portland, Bureau of Maintenance, Traffic Operations Division or from an approved outside source. If obtained from an outside source, it must be submitted and approved prior to incorporation into the sign fabrication.

00940.46 Inspection - The Engineer will inspect signs at the fabrication shop or at the jobsite. Inspection will be for conformance to plans and Specifications. Testing for nighttime visibility will be according to ODOT TM 804. The Contractor's expense for sign inspection will be according to 00165.91.

00940.47 Sign Erection - Erect all signs at the locations staked and as shown or directed. Do not erect individual signs until the sign is complete with legend. Signs not mounted as shown or directed will not be accepted.

Erect the signs so the sign face is vertical, unless otherwise directed.

When signs are installed on supports 10 feet or less from the edge of guardrail, curb, or shoulder, set them to reflect 3° away from traffic. When signs are installed on supports more than 10 feet from the edge of guardrail, curb or shoulder, set them to reflect 3° toward traffic.

The closest edge of any column or overhead sign structures shall be as shown.

Where signs are mounted to supports by bolting through the sign, a sheeting manufacturer-approved lubricant may be used on the nylon and metal washers to prevent sign sheeting deformation. Replace damaged signs, or signs with sheet deformation, with new signs at the Contractor's expense.

If a sign installation is a replacement for an existing sign, install the new sign immediately after removal of the existing sign unless otherwise directed.

Overhead street name signs shall be attached to the mast arm using a stainless steel adjustable banded bracket system, such as Band-It Brack-It D004 or approved equal, sufficient to provide a stable, flat and level sign installation with a minimum of three banded brackets on each sign. The banding shall be cut to length after tightened according to manufacturer specifications. The bands shall be spaced equally and not more than 24 inches apart. The edge of holes drilled in the sign face shall be at least 3/4 inch from the edge of the sign. The overhang of the right and left edges of the signs shall not exceed 15 inches from the outside bands.

The sign shall be placed on the mast arm centered between the inside signal head and the mast arm pole (riser). If no space is available, they shall be placed as directed.

Measurement

00940.80 General - The quantity of signs measured will be the area, to the nearest 0.1 square foot, computed by multiplying height and width, using the dimensions shown. No deductions will be made for irregular shapes cut from the rectangle.

Route markers and other signs fastened to the face of larger signs will be measured as separate signs.

Payment

00940.90 General - The accepted quantities of signs will be paid for at the Contract unit price per square foot, in place, for the item "Type _____ Signs In Place".

The type of sign will be inserted in the blank with a separate pay item provided for each type.

Payment will be payment in full for furnishing all materials, equipment, labor and Incidentals necessary to complete the work.

00940.91 Incidental Basis - When neither the Special Provisions nor the Schedule of Items indicates separate payment for signs, perform the work as incidental work for which no separate payment will be made.

Section 00941 - Sign Covers

Description

00941.00 Scope - This work consists of covering sign faces as shown, specified or directed.

Materials

00941.10 General - For permanent signs, use sign covers from the CPL or porous cloth covers pre-approved by the sign sheeting manufacturer.

Do not use plywood for permanent sign covers.

Covers for temporary signs shall conform to Section 00225.

Construction

00941.40 Fabrication - Fabricate sign covers in one piece, unless otherwise directed. Make them large enough to completely cover the sign, and capable of easy attachment to the sign without damaging the sign face.

00941.41 Installation - Lap covers over all sign edges and secure to the sign or support as recommended by the sign sheeting manufacturer.

00941.42 Alternate - The Contractor may elect one or more of the following as alternate methods subject to approval:

- Install signs in conjunction with the movement of the traffic flow.
- Remove demountable legend from signs and re-install legend as directed.
- Remove entire sign and store in a vertical position for future reinstallation.

Measurement

00941.80 General - Sign covers are considered incidental to the work. No measurement will be made.

Payment

00941.90 General - No separate or additional payment will be made for sign covers or for the alternate methods listed in 00941.42. The cost for this work is included in one or more of the listed pay items.

Section 00950 - Removal and Reinstallation of Highway Illumination and Traffic Signals

Description

00950.00 Scope - This work consists of removing, abandoning, salvaging and reinstalling existing illumination and traffic signal material as shown or directed.

Materials

00950.10 General - The materials covered under this Section are those materials shown, specified and required to properly repair and refurbish salvaged materials that are to be reinstalled.

Construction

00950.40 General - Remove existing illumination or traffic signal devices in the order directed. Do not damage reusable equipment when removing and salvaging existing material. Replace material damaged by the removal and salvage operations at the Contractor's expense. If directed, replace all other material salvaged for reinstallation that is not repairable, or that is not electrically or mechanically sound, with new material according to Section 00196.

Keep existing installations to be removed in operation until the new installations are ready to be turned on or as directed. If downtime is authorized, keep downtime to change from the existing operation to the new operation to a minimum. Perform the changeover with a minimum disruption to traffic.

The method to keep existing traffic signals in operation shall be safe and effective and will be subject to approval on an intersection by intersection basis. The Engineer will assist the Contractor to determine appropriate methods to keep the existing traffic signals operational.

Remove or salvage existing materials, as specified or approved, which interfere with or which are incompatible with new construction, before completion of the new construction. Notify the Engineer at least four calendar days in advance of such action.

00950.41 Removal and Abandonment - Unless otherwise specified, remove from the right of way underground conduit, conductors and foundations not reused and dispose of according to 00310.43. Items not interfering with construction may be abandoned in place with written approval. Plug abandoned conduit.

Wood poles shall be completely removed from the ground.

If a foundation is abandoned, remove the top of the foundation, anchor bolts, and conduits to a depth not less than 2 feet below the adjacent finished ground line. Backfill the resulting hole with material equivalent to the surrounding material. Finish and blend the surface area to the adjacent surface area.

Give the location of all abandoned items to the Engineer.

Correct or repair any holes or damage to existing surfacing caused by removal of existing installations as directed at the Contractor's expense.

00950.42 Stockpiling Existing Materials - Remove, deliver and stockpile all materials specified to be stockpiled at the locations specified [in the Special Provisions](#) or as directed.

00950.43 Reinstalling - If shown or specified, utilize existing material in the construction of new installations. Thoroughly clean, repair and refurbish salvaged material to be reinstalled to a like new condition before reinstallation. Replace damaged parts as directed.

Furnish and install all miscellaneous materials including anchor bolts, nuts, washers and concrete required to complete the reinstallation according to Sections 00960, [00961](#), 00970, and 00990.

Relamp all roadway luminaires, traffic signals and interior illuminated signs to be reinstalled with new lamps of the size and type required for new installations, according to Sections 00970 and 00990, except where such lamp appurtenances as sockets, et cetera, do not permit the installation of the specified lamps. In such instances, furnish and install a new lamp of the same manufacture as is currently installed in the unit.

If it is determined that there are conditions existing within the proposed project scope that do not meet the current applicable electrical codes or variances, obtain approval to furnish and install all necessary materials to meet the applicable electrical codes.

Measurement

00950.80 Lump Sum Basis - There will be no measurement for work done under this Section.

Payment

00950.90 Lump Sum Basis - Payment for work performed under this Section will be made at the Contract lump sum amount for the following items:

Pay Item	Unit of Measurement
(a) Removal of Existing Illumination	Lump Sum
(b) Removal of Existing Traffic Signals	Lump Sum
(c) Reinstallation of Existing Illumination	Lump Sum
(d) Reinstallation of Existing Traffic Signals	Lump Sum

Payment will be payment in full for removing, abandoning, salvaging and reinstalling existing illumination and traffic signals including all materials, equipment, labor and Incidentals necessary to complete the work as specified.

Items shown or specified as work to be done to bring existing installations into conformance with current electrical codes, will be considered incidental to the work and no separate or additional payment will be made.

Items not shown or specified, but necessary to bring existing installations into conformance with current electrical codes, will be paid for according to Section 00196.

No separate payment will be made for traffic signal removal work done under this Section. Payment for removing traffic signal items will be included in payment made for the appropriate items listed in 00990.90.

00950.91 Incidental Basis - When neither the Special Provisions nor Schedule of Items indicate separate payment for the traffic signal work under this section, perform work as incidental to and included in the contract lump sum amount bid for the item "Traffic Signal Installation, Complete".

Section 00959 - Fiber Optics for Telecommunications to Traffic Signals

Description

00959.00 Scope - This work consists of furnishing and installing fiber optic cable for traffic interconnect and camera surveillance as shown. Material and installation shall meet all applicable portions of Sections 00961, 00990 and 02921.

00959.01 Abbreviations:

CFR	-	Code of Federal Regulations
dB	-	Decibel
dBm	-	Decibel referenced to one milli-watt
EIA	-	Electronics Industries Association
FDP	-	Fiber Distribution Panel
FO	-	Fiber Optic
FOIP	-	Fiber Optic Inside Plant
FOOP	-	Fiber Optic Outside Plant
FOTP	-	Fiber Optic Test Procedure as defined by TINEIA standards.
Hz	-	Hertz, cycles per second
Nm	-	nanometer
OD	-	Outside Diameter
OTDR	-	Optical Time Domain Reflectometer
OSHA	-	Occupational Safety and Health Administration
p-p	-	Peak to Peak
REA	-	United States Rural Electrification Administration
Rms	-	root mean square
SM	-	Single Mode
SMFO	-	Single Mode Fiber Optic
SC	-	Type of Fiber Optic Connector

	ST	-	Type of Fiber Optic Connector
	TIA	-	Telecommunications Industries Association

| **00959.02 Definitions:**

| **Connector** - A mechanical device used to align and join two fibers together to provide a means for attaching to and decoupling from equipment or another fiber.

| **Couplers** - A device that mates fiber optic connectors.

| **End to End Loss** - The maximum permissible end to end system attenuation (total loss) in a given link. This loss could be the actual measured loss, or calculated loss using typical (specified) values. This number will determine the amount of optical power (in dB) needed to meet the system performance margin. .

| **Fiber Distribution Panel (FDP)** - A rack or wall mounted unit containing both a patch panel with couplers and splice trays.

| **Handhole** - An underground container used to provide an access point to the fiber cable for conduit routing purposes. This container is typically smaller than a Splice Vault and provides less cable coiling (slack) as well.

| **Jumper** - A short fiber optic cable with connectors installed on both ends.

| **Light Source** - Portable fiber optic test equipment that, when coupled with a power meters, is used to perform end to end attenuation testing. It contains a stabilized light source operating at the wavelength of the system under test.

| **Link** - A passive section of the system, the ends of which are to be connected to active components. May include splices and couplers.

| **Loose Tube Cable** - A type of cable construction in which fibers are placed in buffer tubes to isolate them from outside forces (stress). A flooding compound or material is applied to the interstitial cable core to prevent water migration and penetration.

| **Mid-span Access Method** - A procedure in which fibers from a single buffer tube are accessed and spliced to an adjoining cable without cutting the unused fibers in the buffer tube, or disturbing the remaining buffer tubes in the cable.

| **Optical Attenuator** - An optical element that reduces the intensity of a signal passing through it.

| **Patchcord** - A term used interchangeably with jumper.

| **Pigtail** - A short optical fiber with a connector on a single end.

Power Meter - A portable fiber optic test equipment that, when coupled with a light source, is used to perform an end to end attenuation test. It contains a detector that is sensitive to light at the designed wavelength of the system under test. It displays the amount of optical power being received at the end of the link.

Segment - A section of fiber optic cable that is not connected to any active device and may/or may not have splices per the design.

Splice - The permanent joining of two fiber ends using a fusion splicer.

Splice Closure - An environmentally sealed container used to organize and protect splice trays. The container allows splitting or routing of fiber cables from multiple locations. Normally installed in a splice vault or a handhole.

Splice Tray - A container used to organize and protect spliced fibers.

Splice Vault - An underground container used to house excess cable and splice closures.

00959.03 Required Submittals for Approval - Within 30 days after the contract is awarded, submit to the Engineer a complete listing of all major components of the system. Include the manufacturer's name, model numbers, catalog sheets, and/or other descriptive literature of proposed materials. The catalog cuts and literature shall include technical data, physical properties and operational description in sufficient detail to demonstrate that the equipment meets these specifications.

00959.05 Regulations, Standards, and Codes - The following documents and others referenced therein form part of the Contract to the extent designated in this Specification.

Code of Federal Regulations (CFR)

Title 7 Agriculture

Part 1755 Telecommunications Program standards and specifications -material, equipment, and construction

Electronics Industry Association (EIA)

EIA-455-3A (FOTP 3) Fiber Optic Test Procedures

EIA-455-21A (FOTP 21) Mating Durability for Fiber Optic Interconnecting Devices

EIA-455-25B (FOTP 25) Impact Testing of Fiber Optic Cables and Cable Assembly

EIA-455-33 (FOTP 33) Fiber Optic Cable Tensile Loading and Bending Test

EIA-455-41 (FOTP 41) Compressive Loading Resistance of Fiber Optic Cables

EIA-455-81A (FOTP 81)	Compound Flow (Drip) Test for Filled Fiber Optic Cable
EIA-455-82 (FOTP 82)	Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable
EIA-455-104 (FOTP 104)	Fiber Optic Cable Cyclic Flexing Test
EIA-455-171A (FOTP 171)	Attenuation by Substitution Measurement for Short-Length Multimode Graded-Index and Single Mode Optical Fiber Cable Assemblies
EIA/TIA-568-B.3	Commercial Building Telecommunication Cabling Standard-Part 3 Optical Fiber Cabling Components Standard
EIA/TIA-598	Color Coding of Fiber Optic Cables
EIA/TIA-758	Customer-Owned Outside Plant Telecommunications Cabling Standard

Materials

00959.10 Fiber Optic Cable - Provide single mode fiber optic (SMFO) cables for video and traffic interconnects. SMFO fibers shall contain single mode dual window (1310 nm and 1550 nm) fibers. The cable shall be qualified as compliant with RUS Federal Rule 7CFR1755.900.

(a) Optical Fiber - All fibers in buffer tubes shall be usable fibers, meeting optical, mechanical, and environmental requirements of these special provisions,

(b) Fiber Characteristics and Tests - Single mode fibers shall meet the requirements in the following table:

Fiber Characteristic Table

Parameters	Single Mode
Type:	Step Index
Core diameter:	8.3 μm (nominal)
Cladding diameter:	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
Core to cladding offset:	$\leq 1.0 \mu\text{m}$
Coating:	dual layer, UV-cured acrylate strippable mechanically or chemically without damaging fibers
Optical fibers:	doped silica core with concentric silica cladding
Coating diameter:	250 $\mu\text{m} \pm 15 \mu\text{m}$
Cladding non-circularity defined as:	$\leq 2.0\%$ [1-(min. cladding dia/max. cladding dia.)x100]

FOP cable:	all dielectric, gel-filled, duct-type
Proof/Tensile Test:	345 MPa, min
Attenuation at 1310 nm and at 1550 nm:	≤ 0.4 db/km
Test cable in accordance with:	EIA-455-25 (FOTP-25) EIA-455-33 (FOTP-33 Condition II) EIA-455-41 (FOTP-41) EIA-455-81 (FOTP-81) EIA-455-82 (FOTP-82) EIA-455-104 (FOTP-104 Conditions I and II)
Test optical fiber in accordance with:	EIA -455-3A (FOTP-3)
Attenuation at the Water Peak:	≤ 2.1 dB/km @ 1383 ± 3 nm
Chromatic Dispersion	
Zero Dispersion Wavelength:	1301.5 to 1321.5 nm
Zero Dispersion Slope:	≤ 0.092 ps/(nm ² *km)
Maximum Dispersion:	≤ 3.3 ps/(nm ² *km) for 1285 -1330 nm ≤ 0.092 ps/(nm ² *km) for 1550 nm
Cut-Off Wavelength:	<1250 nm
Mode Field Diameter	9.3 ± 0.5 μ m at 1310 nm
(Petermann II)	10.5 ± 1.0 μ m at 1550 nm

(c) Color Coding - In buffer tubes containing multiple fibers, each fiber shall be distinguishable from others in the same tube by means of color coding according to the following:

- | | |
|----------------|-----------------|
| 1. Blue (BL) | 7. Red (RD) |
| 2. Orange (OR) | 8. Black (BK) |
| 3. Green (GR) | 9. Yellow (YL) |
| 4. Brown (BR) | 10. Violet (VL) |
| 5. Slate (SL) | 11. Rose (RS) |
| 6. White (WT) | 12. Aqua (AQ) |

Buffer tubes shall also be color coded with distinct and recognizable colors according to the same table listed above for fibers. These colors shall be targeted in accordance with the Munsell color shades and shall meet EIA/TIA-598.

The color formulation shall be compatible with the fiber coating and the buffer tube filling compound, and be heat stable. It shall not fade, smear or be susceptible to migration and it shall not affect the transmission characteristics of the optical fibers and shall not cause the fibers to stick together.

(d) Cable Construction - The fiber optic cable shall consist of, but not limited to, the following components:

(1) Buffer Tubes - Clearance shall be provided in the loose buffer tubes in fibers and the inside of the tube to allow for expansion without constraining the fiber. The fibers shall be loose or suspended within the tubes. The fibers shall not adhere to the inside of the buffer tube. Each buffer tube shall not exceed a maximum of 12 fibers. Provide the number of fibers per cable as shown on the plans:

The loose buffer tubes shall be extruded from a material having a coefficient of friction sufficiently low to allow free movement of the fibers. The material shall be tough and abrasion resistant to provide mechanical and environmental protection of the fibers, yet designed to permit safe intentional "scoring" and breakout, without damaging or degrading the internal fibers.

Buffer tube filling compound shall be a homogenous hydrocarbon based gel with antioxidant additives used to prevent water intrusion and migration. The filling compound shall be non-toxic and dermatologically safe to exposed skin. It shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, non-hygroscopic and electrically non-conductive. The filling compound shall be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around a central member by a method, such as reverse oscillation stranding process, which will prevent stress on the fibers when the cable jacket is placed under strain.

(2) Central Member - The central member which functions as an anti-buckling element shall be a glass reinforced plastic rod with similar expansion and contraction characteristic as the optical fibers and buffer tubes. To ensure the proper spacing between buffer tubes during stranding, a symmetrical linear overcoat of polyethylene may be applied to the central member to achieve the optimum diameter.

(3) Filler Rods - Fillers may be included in the cable to maintain the symmetry of the cable cross section. Filler rods shall be solid medium or high-density polyethylene. The diameter of filler rods shall be the same as the outer diameter of the buffer tubes.

(4) Stranding - Completed buffer tubes shall be stranded around the overcoated central member using stranding methods, lay lengths and positioning such that the cable shall meet mechanical, environmental and performance specifications. A polyester binding shall be applied over the stranded buffer tubes to hold them in place. Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

(5) Core and Cable Flooding - The cable core interstices shall contain a water blocking material, to prevent water ingress and migration. The water blocking material shall be either a polyolefin based compound which fills the cable core interstices, or an absorbent polymer, which fills voids and swells to block the ingress of water. The flooding compound or material shall be homogeneous, non-hygroscopic, non-conductive, and non-nutritive to fungus. The compound or material shall also be nontoxic, dermatologically safe and compatible with other cable components.

(6) Tensile Strength Member - Tensile strength shall be provided by high tensile strength aramid yarns and/or fiberglass which shall be helically stranded evenly around the cable core and shall not adhere to other cable components.

(7) Ripcord - The cable shall contain at least one ripcord under the jacket for easy sheath removal.

(8) Outerjacket - The jacket shall be free of holes, splits, and blisters and shall be medium or high density polyethylene, or medium density cross linked polyethylene with minimum nominal jacket thickness of 1/32 inches $\pm$ 0.003 inches. Jacketing material shall be applied directly over the tensile strength members and water blocking materials and shall not adhere to the aramid strength material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The jacket or sheath shall be marked with the manufacturer's name, the words "Optical Cable", the number of fibers, "SM", year of manufacture, and sequential measurement markings every meter. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 3/32 inches.

(e) Packaging and Shipping Requirements - Pack completed cable on reels for shipment. Wrap cable in weather and temperature resistant covering. Seal both ends of cable to prevent ingress of moisture. Secure each cable end to the reel to prevent the cable from coming loose during transit. Have at least 72 inches of cable length accessible for testing purposes.

Label each cable reel with a durable, weatherproof label showing manufacturer's name, cable type, actual length of cable on the reel, Contractor's name, contract number, and reel number. Include a shipping record in a weatherproof envelope showing the above information and also include the date of manufacture, cable characteristics (size, attenuation, bandwidth, etc.), factory test results, cable identification number and any other pertinent information.

Minimum hub diameter of reel shall be at least thirty times the cable diameter. Fiber optic cable shall be continuous length on each reel. Mark reel indicating direction reel should be rolled to prevent loosening of cable.

Furnish installation procedures and technical support information at delivery.

(f) Labeling - Label all fiber optic cabling in a permanent and consistent manner. All tags shall be of a long life material and shall be marked with permanent ink on non-metal types, or embossed lettering on metals tags. Metal tags shall be constructed of stainless steel. Labels shall be affixed to the cable per the manufacturer's recommendations and shall not be affixed in a manner which will cause damage to the fiber. Handwritten labels shall not be allowed.

00959.11 Fiber Optic Cable Assemblies and Pigtails:

(a) General - Cable assemblies (pigtails and jumpers) shall be products from the same manufacturer. The fiber optic cable used for cable assemblies shall be made of fiber meeting the performance specifications of Section 00959.11.

(b) Pigtails - Pigtails shall be of simplex (one fiber) construction, in 900 μ m tight buffer form, surrounded by aramid for strength, with a PVC jacket with manufacturer identification information, and a nominal outer jacket diameter of 1/8 inch. Simplex cable jackets shall be yellow in color. All pigtails shall be factory terminated and tested and at least six feet in length.

(c) Jumpers - Jumpers may be of simplex or duplex design. Duplex jumpers shall be of duplex round cable construction. All jumpers shall be at least 6 feet in length, sufficient to avoid stress and allow orderly routing. The outer jacket of duplex jumpers shall be yellow in color. The two inner simplex jackets shall be contrasting colors to provide easy visual identification of polarity.

(d) Connectors - Connectors shall be of the ceramic ferrule ST or SC type for single mode fiber. Connector body housing shall be glass reinforced polymer. The associated coupler shall be of the same material as the connector housing. Each connector shall not exceed 0.75 dB loss as specified by EIA/TIA-568-B.3.

(e) Fiber Distribution Unit (FDU) - The fiber distribution unit shall consist of a EIA 482.6 mm rack, a compartment for termination and distribution cable tray and a compartment for a splice drawer. The termination and distribution cable trays shall accommodate 48 singlemode optical fiber cables. The termination and distribution cable trays shall have sufficient tray areas for excess optical fiber storage with provisions to assure that the optical fibers do not exceed a 2-inch bend radius. The termination and distribution cable trays shall include a designation strip for identification of the 48 optical singlemode optical fibers. Each splice drawer shall include two splice trays with each splice tray capable of accommodating 48 fusion type splices. Each splice drawer shall allow for storage of excess lengths of the optical fibers of fiber optic cables. Each fiber distribution unit shall be provided with cable clamps to secure fiber optic cables to the chassis.

Labor

00959.30 Licensed Electricians - Electrical work shall be in accordance with 00960.30. In addition to submitting electrician's license, those individuals performing fiber terminations and splices must possess either a Fiber Optics Installer or Fiber Optics Technician Certification recognized by the Electronics Technicians Association. Submit a copy of certification prior to performing any work.

Construction

00959.40 Installation and Setup:

(a) Cable Installation - Submit manufacturer's recommended procedures for pulling fiber optic cable for review 20 days prior to beginning installation. Mechanical aids may be used in cable installation. Place tension measuring device or breakaway swivel between ends of cable grip and pull rope to ensure tension does not exceed 80 percent of recommended tension or 2225 N, whichever is less. Use cable grips with a ball bearing swivel for installing fiber optic cable to prevent cable from twisting during installation.

During installation, maintain a minimum bend radius of 20 times the outside diameter of the cable. Do not stress the cable beyond the minimum bend radius. Install fiber optic cable using cable pulling lubricant as recommended by the manufacturer. Use a non-abrasive pull tape. Station personnel at each splice vault and hand hole to lubricate the cable and prevent kinking or other damage. Install fiber optic cable without splices, except as specifically allowed for on the plans, as described herein, or as directed. Divide slack equally on each side of splice closures. Following installation of cable in conduit, seal all entrances in cabinets, junction boxes and vaults with duct sealing compound to keep out moisture, foreign materials, and rodents.

(b) Splicing - Optical fibers shall be spliced using the fusion type and shall not exceed 0.07 dB loss per splice. Place splice tray in a splice closure unless using a splice enclosure. Protect all splices with a thermal shrink sleeve.

The completed splices shall be placed in a splice tray. The splice tray shall then be placed in the splice closure. All splices shall be protected with a thermal shrink sleeve. All fibers shall be labeled in the splice tray with permanent vinyl markers. Pigtail ends shall also be labeled to identify the destination of the fiber.

(c) Splice Closures - The fiber optic field splices shall be enclosed in splice closures which shall be complete with splice organizer trays, brackets, clips, cable ties, seals and sealant, as needed. The splice closure shall be suitable for a direct burial or pull box application. Manufacturer's installation instructions shall be supplied to the Engineer prior to the installation of any splice closures. The splice closure shall meet the following requirements:

- Non-filled thermoplastic case
- Rodent proof, water proof, re-enterable and moisture proof
- Expandable from 2 cables per end to 8 cables per end by using adapter plates
- Cable entry ports shall accommodate 7/16 inch to 1 inch diameter cables
- Multiple grounding straps
- Accommodate up to 8 splice trays
- Suitable for "butt" or "through" cable entry configurations
- Place no stress on finished splices within the splice trays

The splice closure shall be attached to the inside wall of the vault or handhole. The splice closure shall be 3M 2178-L/S series, Coyote Closure series, Tyco Raychem series or approved equal.

(d) Splice Trays - Splice trays must accommodate a minimum of 12 fusion splices and must allow for a minimum bend radius of 1-3/4 inches. Individual fibers must be looped one full turn within the splice tray to allow for future splicing. No stress is to be applied on the fiber when it is located in its final position. Buffer tubes must be secured near the entrance of the splice tray. Buffer tubes shall be securable with channel straps.

Splice trays shall be of the same manufacturer as the splice closure.

(e) Cable Terminations - At the FDP, the cable jacket of the SMFO cable, shall be removed exposing the aramid yarn, filler rods, and buffer tubes. The exposed length of the buffer tubes shall be at least the length recommended by the FDU manufacturer which allows the tubes to be secured to the splice trays. Each buffer tube shall be secured to the splice tray in which it is to be spliced. The remainder of the tubes shall be removed to expose sufficient length of the fibers in order to properly install on the splice tray.

The cable shall then be spliced and secured with tie warps and routed to its appropriate fiber distribution unit location.

When applicable, the moisture blocking gel shall be removed from the exposed buffer tubes and fibers. The transition from the buffer tube to the bundle of jacketed fibers shall be treated by an accepted procedure for sleeve tubing, shrink tube and silicone blocking of the transition to prevent future gel leak. Manufacturer directions shall be followed to ensure that throughout the specified temperature range gel will not flow from the end of the buffer tube. The individual fibers shall be stripped and prepared for splicing.

Factory terminated pigtails shall then be spliced and placed in the splice tray.

All fibers entering the FDP shall be terminated and labeled.

A transition shall then be made, with flexible tubing, to isolate each fiber to protect the individual coated fibers. The final transition from bundle to individual fiber tube shall be secured with an adhesive heat shrink sleeve.

(f) Distribution Breakout - Terminate distribution breakout in a fiber distribution panel. Remove cable jacket, aramid yarn and filler rods, and expose buffer tubes. Expose buffer tubes as recommended by manufacturer. Secure buffer tubes to splice tray. Remove remainder of tubes and expose individual fibers for routing on splice tray as described in 00959.30(b). Remove moisture blocking gel from exposed buffer tubes and fibers following manufacturer's directions to ensure gel will not flow from end of buffer tube. Strip and prepare individual fibers for splicing onto factory prepared pigtails. Connect pigtails to the distribution panel's couplers. Use factory prepared jumpers to connect between the FDP couplers to individual components.

(g) Fiber Distribution Panel Installation - At traffic controller cabinet locations, provide a single-height rack mount type fiber distribution panel with a drop cable, equivalent to the Gator Patch ITS Drop Cable (GP2 G12 FNB-GP

Finishing and Testing

00959.70 Testing:

(a) Test Plan - Prior to beginning testing, submit for approval five copies of installation and test plan detailing methods of installation and testing for all materials, equipment, and systems. At the same time, submit the associated schedule of activities. Notification of approval or rejection will be made within four weeks. If the test plan is rejected, submit a revised test plan within 20 working days. Do not begin testing until receiving approval of the test plan by the Engineer. Submit all test results, including results of failed tests or retests to the Engineer. The Contractor shall supply all test equipment.

Provide 48 hours notice of intent to proceed prior to commencing each functional and/or subsystem test. In the notice, provide location(s) of test(s). Conduct environmental tests of field equipment as part of the functional tests. Subsystem testing and inspections shall include visual inspection from damaged or incorrect installation, adjustments, alignments, and measurement of parameters and operating conditions.

(b) Factory Testing - Documentation of compliance with the fiber specifications as listed herein shall be supplied by the original equipment manufacturer. Before shipment, but while on the shipping reel, 100 percent of all fibers shall be tested for attenuation. Copies of the results shall be maintained on file by the manufacturer with a file identification number, attached to the cable reel in a waterproof envelope, and submitted to the Contractor and Engineer.

(c) Arrival On-Site Testing - Each cable and reel shall be physically inspected upon delivery and 100 percent of the fibers shall be attenuation tested to confirm that the cable meets the requirements. The failure of any single fiber in the cable to comply with these specifications is cause for rejection of the entire reel. Test results shall be recorded on the Cable Verification Worksheet, dated, compared, and filed with the copy accompanying the shipping reel in a waterproof envelope. The cable shall not be installed until completion of this test sequence and the Engineer provides written approval. Copies of traces and test results shall be submitted to the Engineer. If the tests are unsatisfactory, the reel of cable shall be considered unacceptable and all records corresponding to that reel shall be marked accordingly. The unsatisfactory reels of cable shall be replaced with new reels of cable at Contractor's expense. The new reels of cable shall be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.

(d) Fiber Optic Cable Testing - Testing shall include the tests on elements of the passive FO components. (1) at the factory, (2) after delivery to the project site, but prior to installation, (3) after installation, but prior to connection to any other portion of the system. Provide all personnel, equipment, instrumentation, and materials necessary to perform all on-site testing.

Provide documentation of all test results to the Engineer at most two working days after the test is completed. At least 15 working days prior to the arrival of cable on site, provide detailed field testing procedures. In the procedures include the test involved and method by which tests are to be conducted. Include in the notification the model, manufacturer, configuration, calibration, and alignment procedures for all proposed test equipment

(e) Outdoor Splices - Verify insertion loss quality of each splice prior to sealing splice closure.

(f) Cable Verification:

(1) OTDR Testing - Once the cabling system has been installed and is ready for activation, test all fiber links with the OTDR test equipment for attenuation at wavelengths of both 1310 nm and 1550 nm. Index matching gel shall not be allowed in connectors during testing. Record, date and compare test results and file with previous copies. Submit hard copy printout of traces and test results to the Engineer. The OTDR shall be capable of recording and displaying anomalies of at least 0.02 dB.

(2) Power Meter and Light Source Testing - At the conclusion of the OTDR testing, 100 percent of the fiber links shall be tested end to end with a power meter and light source, in accordance with FOTP-171 and in the same wavelength specified for the OTDR tests. These tests shall be conducted in one direction. The insertion loss shall be calculated. Test results shall be recorded, compared, and filed with the other recordings of the same links. Test results shall be submitted to the Engineer. Record the values in the Cable Verification Worksheet. The power meter shall be calibrated with traceability to the National Institute of Standards and Technology (NIST).

(3) Cable Verification Worksheet - Complete the Cable Verification Worksheet shown at the end of this section. Include the completed worksheets as part of the system documentation.

(4) Test Failures - If the link loss measured from the power meter and light source exceeds the calculated link loss, or the actual location of the fiber ends does not agree with the expected location of the fiber ends (as would occur with a broken fiber), the FO Link will be rejected. Replace the unsatisfactory segments of cable, or splices with a new segment of cable or splice at the Contractor's expense. Complete the OTDR Testing, Power Meter and Light Source Testing, and Cable Verification Worksheet for the repair to determine acceptability. Submit copies of the test results to the Engineer. The removal and replacement of a segment of cable shall be interpreted as the removal and replacement of a single continuous length of cable connecting two splices, two connectors. The removal of only the small section containing the failure and therefore introducing new unplanned splices will not be allowed.

Measurement

00959.80 Lump Sum Basis - There will be no separate measurement of work done under this Section.

Payment

00959.90 General - Installing fiber optic cable will be paid for at the Contract lump sum amount for the item "Fiber Optic Cable". Payment will be payment in full for all materials, equipment, labor and incidentals necessary to complete the work.

Cable Verification Worksheet

End to End Attenuation Testing with a Power Meter, Light Source, and an OTDR

Contract No.: _____ Contractor: _____

Operator: _____ Date: _____

Link Number: _____ Fiber Number: _____

Test Wavelength (Circle one): 1310 _____ 1550 _____

Expected location of fiber ends: End 1: _____ End 2: _____

Power Meter and Light Source Test Results:

Power In: _____ dB m 1A

Output Power: _____ dB m 1B

Insertion Loss (1A – 1B): _____ dB m 1C

OTDR Test Results:

Forward Loss: _____ dB m 2A

Reverse Loss: _____ dB m 2B

Average Loss [(2A + 2B)/2]: _____ dB m 2C

To be completed by City of Portland:

Engineer's Signature: _____ Cable Link Accepted: _____

Fiber System Performance Margin Calculations Worksheet

A. Calculate the Passive Cable Attenuation

1. Determine the Fiber Loss at Operating Wavelength: _____nm

Cable Distance x Individual Fiber Loss: _____km x _____dB/km = _____dB
 at 1310 nm (0.4 dB/km)
 at 1550 nm (0.25 dB/km)

B. Calculate the Total Connector/Splice Loss

2. Determine Maximum Allowable Connectors Loss:
 (Excluding transmitter and receiver connectors)

Individual connector loss x number of connector pairs along one fiber path

| 0.75 dB x ____ = _____dB

Provide documentation demonstrating installation does not exceed the above number.

3. Calculate Splice Loss:

Individual splice loss x number of splices along one fiber path

| 0.1 dB x ____ = _____dB

Provide documentation demonstrating installation does not exceed the above number.

4. Determine Other Components Power:

Provide documentation of output power of each fiber optic modem and video transmitter.

5. Calculate Total Losses:

| Video: B.4 -A.1 -B.2 -B.3 = _____dB

| Traffic Controller: B.4 -A.1 -B.2 -B.3 = _____dB

Section 00960 - Common Provisions for Highway Illumination and Traffic Signals

Description

00960.00 Scope - This work consists of furnishing and installing materials for highway illumination and/or traffic signal projects and for modifying existing installations. The location of illumination/signal material shown is approximate, with exact locations established in the field.

00960.01 Regulations, Standards, and Code - All electrical materials and workmanship shall conform to the following standards where applicable:

- American National Standards Institute (ANSI)
- International Municipal Signal Association (IMSA)
- Underwriter's Laboratories, Inc. (UL)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
- National Electrical Code, Oregon Amended (NEC)
- Standards of the American Society for Testing and Materials (ASTM)
- Local laws

Wherever reference is made to any of the standards mentioned above, the reference means the code, order, or standard in effect on the date the Project is advertised.

Do not begin illumination and/or traffic signal installations until all permits are obtained and copies are given to the Engineer.

00960.02 Equipment List and Drawings - Within 30 calendar days after execution of the Contract, submit at least **three** copies of:

- **Cut sheets for materials** that the Contractor proposes to install, unless otherwise permitted in writing. List all material shown or specified by manufacturer's name, size, and identity number of each item, if it is necessary or customary in the trade to identify such materials. Supplement the list with other data, including but not limited to, detailed scale drawings according to 00150.35.
- Wiring diagrams for all circuits and any nonstandard or special equipment.
- Brochures, technical bulletins, parts lists, service instructions, working drawings and other technical information relative to products proposed for use on the Project.
- Designs of all poles and nonstandard pole foundations.

- Submittals shall be in orderly bound form with specific items for installation clearly marked. Partial submittals will not be accepted.

All engineered details and drawings, which are not prepared by the City, but are required in the Contract Documents, shall be submitted for review prior to fabrication. Designs, details, plans and calculations shall be stamped and submitted according to 00150.35(m)(1).

Upon completion of the installation, submit six copies of any data required to show in detail all changes made from the original plans. The information furnished shall include all modifications made and shall represent the material installed and in operation. It shall be sufficiently detailed to enable maintenance forces to replace or repair any part of the Project under routine or emergency maintenance by direct reference.

Materials

00960.10 General - Materials shall meet the following requirements:

Aluminum Poles.....	02920.31
Anchor Bolts	02920.34
Ballasts	02920.52
Cabinets	02920.40
Cable and Wire	02920.20 -.28
Circuit Breakers	02920.41
Conduit	02920.10 -.12
Detection Devices.....	02920.45
Electrical Splice Materials.....	02920.25
Frangible Bases.....	02920.33
Illumination Control Devices	02920.42
Interior Illumination Signs	02920.61
Junction Boxes	02920.13
Lamps.....	02920.50 -.51
Luminaires	02920.53
Signal Indication Devices.....	02920.60
Steel Poles.....	02920.31
Steel Towers.....	02920.32
Traffic Signal Control Devices	02920.42
Wood Poles	02920.30

00960.11 Temporary Plating - Temporary plating shall conform to Section 00275.

Labor

00960.30 Licensed Electricians - In accordance with Oregon Administrative Rule 918-282-0120(1), every person engaged in the installation of electrical equipment and wiring systems shall possess a valid Oregon Electrical Supervising or Journeyman's License, or be registered as an Electrical Apprentice. Every person who installs electrical systems on the Project shall submit a copy of his/her electrical license or apprentice registration to the Engineer prior to performing any work. Contractor employees who are

not licensed electricians or registered apprentices will not be allowed to perform electrical work. This includes, but is not limited to:

- Assembling conduit systems
- Installing field mounted enclosures, junction boxes, and terminal cabinets
- Installing or splicing wiring for vehicle detector systems
- Participating in the installation of electrical conductors in conduits or poles (i.e. pulling wire)

Construction

00960.40 General - Complete all construction according to the Contract Documents or as directed.

Correct faulty workmanship and materials at no cost to the Owner, even if not notified by the Engineer.

The Owner will continue operation and maintenance, including the furnishing of electrical energy, of existing signal facilities.

Maintain new signal equipment until notification by the Engineer. The Owner will continue to furnish electrical energy.

00960.41 Excavation:

(a) General - Protect all existing pipes that become a part of a foundation as directed by the Engineer.

Do all excavation, backfilling and resurfacing work necessary to complete the work. This includes removal and replacement of curbs, sidewalks, paved surfaces and other materials. On completion of the work, replace and finish all surfaces to correspond with the existing surfaces.

Excavate trenches to lines, grades and cross sections established or approved. Furnish, place, and remove any shoring required to prevent caving of walls.

When excavating in paved areas, [cut through to the base material and along a T cut of the area with a minimum 6 inches overlap](#) along the neat boundaries of the area to be removed. Cut sharp and well-defined pavement edges with no evidence of cracking, delaminating, or stressing.

Do not install conduit by means of plowing without approval. Submit the request in writing and include details on how the plowing will be performed.

Restore all disturbed landscaping and underground systems to original condition at Contractor's expense upon completion of the work. Use hand excavation if directed.

(b) Excavation for Pole, Pedestal and Tower Foundations - Make all excavations for pole, pedestal and tower foundations to the neat lines of the foundations. Hand excavation may be required. Place the concrete directly against the sides of the excavation in undisturbed or well-compacted material.

(c) Excavation for Conduit - All underground conduit runs shall be placed with a minimum of 36 inches and a maximum of 42 inches of cover below the surround surface. Stub conduits for detector loop pockets shall be placed as close as possible to the bottom of the curb. Stub conduits extend 6" past the face of the curb and gutter.

Special precautions should be taken when installing conduits in the vicinity of NW Natural Gas Company mains. These mains are protected by cathodic protection system. Any contact with electrically ground conduits will interfere with this cathodic protection systems. Maintain 12 inches of separation from gas mains where practical. If this is not possible, notify NW Natural Gas Company so that they can insulate the conduit from the main while the trench is open.

Place the conduit under curbs without disturbing curbs.

If the trench is not backfilled the same day the rigid nonmetallic conduit is placed:

- Cap or plug all conduit ends,
- Leave one end of conduit run free until backfill is started, or
- Install a rigid, nonmetallic conduit expansion joint in the run

(d) Conduit under Paved Surfaces - Install conduit under all paved surfaces by horizontal directional drilling or the open trench method.

(1) Horizontal Directional Drilling - Drilling shall not "hump" or deform the pavement and shall be guided. Pneumatic hammers are not allowed. Keep drilling pits at least 2 feet from the edge of pavement unless otherwise authorized in writing. Do not use water to the extent that the pavement might be undermined or subgrade softened. Sand bedding and marking tape are not required with this method. When the work must be left overnight, cover the drilling pit with adequate planking.

(2) Open Trench - If the open trench method is used, do the following:

- a. **Width** - Hold trench width to a practical minimum.
- b. **Pavement Cuts** - Cut the existing pavement as required in 00960.41(a).

(e) Conduit under Railroad Tracks - Install conduit inside a galvanized, rigid metal conduit at the depth required by the governing railroad company. Construct so that conduit ends are at least 12 feet beyond the centerline of every track or other distance as required by the railroad. When the work must be left overnight, cover the drilling pit with adequate planking.

(f) Disposition of Waste Materials - On completion of the work, or as directed, dispose of all waste materials according to 00330.41(a)(6) or as directed.

(g) Backfill - Use an approved sand blanket, selected general backfill meeting the requirements of 00330.13, selected granular backfill meeting the requirements of 00330.14, or concrete meeting the requirements of Section 00440 as follows:

(1) Rigid Nonmetallic Conduit:

a. Bedding - Place 2 inches of approved sand blanket in trench bottom before placing conduit.

b. Cover - Cover conduit with 2 inches of additional sand drainage blanket.

c. Backfill - Backfill according to the following:

1. New Roadway and Shoulder, or Existing Non-roadway, Non-shoulder Pavement - Place selected granular backfill material in layers not greater than 6 inches thick. Compact the selected granular backfill material according to 00405.46(c)(2).

2. Existing Roadway and Shoulder - Backfill all traffic signal conduit trenches in roadway areas (including paved shoulders) in the following manner:

Construct CLSM backfill according to 00442, placed to an elevation 6 inches below the surface of the existing pavement or to the bottom of the existing pavement, whichever is lower. When this method is used the sand blanket may be omitted.

3. Unpaved Areas - Place selected granular backfill material in layers not greater than 6 inches thick. Compact the selected granular backfill material according to 00405.46(c)(2) to the top of trench, surrounding ground level or upper limit of excavation as directed. The sand drainage blanket requirement of a. and b. above may be deleted as approved when excavated material does not contain large, angular stones that could fracture or dent conduit.

d. Pavement - Place and compact AC according to 00749.13 or PCC according to Section 00755 as follows, unless otherwise directed.

1. Existing Non-roadway, Non-shoulder Pavement - Match surfacing thickness.

2. Existing Roadway and Shoulder - In paved areas, pave to a minimum thickness of 6 inches.

e. Finish - In paved areas, finish to a smooth riding surface.

(2) Rigid Metal or Intermediate Metal Conduit - Omit the sand drainage blanket of a. and b. above, and backfill according to c.

00960.42 Conduit:

(a) General - Conduit runs shown on the plans are for bidding purposes only. Locations may be changed to avoid obstructions, if approved. Larger size conduit than specified may be used at the option and expense of the Contractor. Use it for the entire length of the run from outlet to outlet. Reducer couplings will not be permitted. Install all underground conduit runs and conduit risers on poles as needed, even if not shown.

All conduit shall be rigid PVC schedule 80 unless otherwise indicated on the plans and details. Where shown on plans, galvanized rigid metal conduit in conformance with 2920.10(a) shall be used.

Use rigid metal conduit elbow when converting from an underground, rigid, nonmetallic conduit to an aboveground run or extension. Bond all metallic lids for junction boxes containing 120+ VAC regardless of the elbow material type, riser material type, or bushing material type.

Each conduit over 1 inch except service conduits shall have one yellow #12 THWN stranded copper wire as a locate wire. Extend the wire 2 feet beyond conduit ends and install a wire nut. Do not join multiple locate wires under a common wire nut.

Each conduit shall have polyester line installed with a break strength of at least 1250 lbs and 40 inches of slack, tied off at each end of the conduit run. Any pull lines utilized by the Contractor shall be replaced with a new polyester pull line.

If corrosive soil conditions exist and if shown or specified, coat metallic conduit with a non-metallic coating or wrap with corrosion protection tape according to 00960.41(c).

(b) Conduit on Wood Poles - Mount conduit on City-owned wood poles with two-hole, galvanized, steel conduit straps spaced no more than 3 feet apart. Mount conduit on utility-owned wood poles according to local utility regulations. Use stand-off brackets if required.

(c) Conduit on Metal Poles - Mount conduit on metal poles with 3/4 inch, stainless steel straps or a single-hole, galvanized metal strap, drilled and tapped with galvanized bolts. Place straps no more than 3 feet apart. After tightly drawing steel bands, cut and fold under the ends to eliminate protruding edges. Mount only service conduit on the outside of poles unless otherwise shown or approved.

(d) Conduit in Foundations - Use rigid metal conduit and extend it 2 inches to 3 inches above the top of the cabinet foundations. Install conduit within 6 inches of the hand hole for illumination and traffic signal poles. Extend the conduit beyond the face of curb and gutter, or as shown on the detail drawings. Conduit for service equipment ground rod conductors shall be 1/2 inch PVC Schedule 40

Ground rods shall be installed diagonally into the foundations as described under 00960.50(b).

Group conduits in foundations so that, with the pole in place, it is possible to place an insulated bushing on each conduit end. On breakaway poles, do not extend the conduit above the slip plane of the base.

Place all conduit in the foundation. Surface-mounted conduit will not be accepted.

When a new conduit is required in an existing signal foundation, install the conduit by cutting a slot in the foundation, without cutting reinforcing steel, or by core drilling, as directed. Install the conduit and patch the opening with grout. Extend the new conduit far enough into the base of the pole to allow attachment of a ground clamp or bonding bushing. Bond the new conduit to the ground lug inside the pole with a No. 6 AWG copper bonding jumper. Do not damage the surrounding foundation or reinforcement during these operations. Do not use pavement-breaking equipment.

Install the conduit into an existing controller using an "LB" fitting and conduit hub through the controller riser frame.

(e) Underground Conduit Installation - Make conduit runs continuous between any pole, junction box, or cabinet. Give the location of conduit and junction boxes to the Engineer. Permanently mark all underground conduit runs by installing an underground marking tape directly over the conduit.

The underground marking tape shall be:

- A red polyethylene film, 6 inches wide, and at least 4 mils thick
- Imprinted with the following or similar legend:

CAUTION CAUTION CAUTION BURIED ELECTRIC LINE

- Placed 6 inches $\pm$ 1 inch below the surface
- Continuous between pole bases, junction boxes and cabinet locations

Do not cover conduit runs until inspected.

Installation of HDPE conduit may be by drilling or open trench methods, or by plowing if approved. Minimum cover shall be 3 feet.

(f) Conduit Bends - Use a standard factory bend where a conduit bend is required, unless factory conduit bend sizes are not commercially available, or a special bend is required. Bends performed on the job or in the shop shall:

- Have a radius of at least six times the inside diameter of the conduit
- Be bent without crimping or flattening
- Be rigid metal conduit conforming to 02920.10(a), or 02920.10(b) if the bend is 45° or more, unless otherwise specifically permitted.

(g) Conduit Ends and Couplings - Ream the ends of all conduits whether cut in the shop or field, to remove burrs and rough edges. Make cuts square and true so the ends will fit together for their full circumference. Slip joints or running threads will not be permitted for coupling conduit. Use an approved threaded union coupling when a standard coupling cannot be used.

Paint the following with rust-preventative coating:

- Threads on all metal conduit before couplings are made up
- Areas where the coating has been damaged so underlying metal is exposed
- Exposed, ungalvanized threads resulting from field cuts

Tighten all couplings until the conduit ends are brought together throughout the entire length of the run.

Cut nonmetallic conduit with a hacksaw or other approved tool, and connect with solvent welds.

Plug or cap all conduit ends with approved material until wiring is started.

Use a nonmetallic female threaded connector to connect nonmetallic conduit to metallic conduit.

Use PVC bell end fittings on all PVC conduit ends. Use insulated metallic bushings on all metal conduit ends. Ground bushings where metal conduit contains AC circuits; bushing on conduits containing only DC circuits need not be grounded. Bond conduit end bushings to the equipment ground wire, and connect the grounding bushings in the metal pole to the pole grounding lug with a jumper. Install insulated bushings on all metal conduits. For ground rod conduits, use push-on nylon/PVC bushings.

A closed cell polyethylene plug shall be installed in all conduits that terminate less than 20 inches above ground level to prevent moisture and foreign objects from entering the conduits. All conduit ends shall be sealed using care to notch the plug to encase conductors and cables to achieve a secure seal. The plugs shall be used continuously during all stages of construction so that the conduits are kept clean and free of foreign materials.

All closed cell polyethylene plugs shall meet or exceed the following specifications:

Density = 2 lb./cubic foot
 Tensile strength = 25 psi
 Water Absorption = 0.5% by volume
 Compression Deflection = 25% at 8 psi
 Compression Recovery = 90% per minute

Plug diameters shall be 1/4 inch larger than the conduit diameter for conduits sizes from 1/2 inch to 1 1/4 inches. These plugs shall be 2 inches to 3 inches long. Plug diameters shall be 1/2 inch larger than the conduit diameter for conduit sizes from 1 1/2 inches to 4 inches. Plugs for 1 1/2 inches to 2 1/2 inches conduits shall be 3 inches long. Plugs for 3 inches to 4 inches conduits shall be 4 inches long. Approximately one third of the plug length shall be exposed after installation. Plugs shall be Molded Plug® plugs or approved equivalent.

(h) Conduit in Junction Boxes:

(1) General - Install conduit in junction boxes according to the following:

- Enter through the bottom of boxes where possible.
- Enter the box from the direction of the run.
- Terminate conduit 1 inch inside the box wall when entering through the side walls.
- Use factory 90° galvanized rigid metallic bends.

(2) Cast Iron Junction Boxes - Conduit entrances into new or existing cast iron junction boxes shall:

- Use a watertight malleable iron hub for metal conduit entrances.
- Use a watertight malleable iron hub when NEMA 3R or NEMA 4 junction boxes are specified.
- Be cut with a hole saw.

Repair damage to galvanizing of existing cast iron junction boxes as directed.

(3) Concrete Junction Boxes - Install conduit entrances into concrete junction boxes according to the following:

- Locate conduits near the end walls to leave the major portion of the box clear.
- Orient conduit ends towards the top of the box so that conductors may be pulled out of the conduit from the top of the box without touching the side of the box or other conduits.

(i) Conduit Installed for Future Use - If conduit is noted on the plans for future use, with no conductors installed, insert a yellow #12 AWG conductor and a coated polyester pull tape with at least 1250 pounds break strength. The pull line is to be replaced when new conductors are installed.

In poles, controller boxes, and junction boxes leave 3 feet of slack in the polyethylene line.

(j) Existing Conduit - Use existing conduit only where shown. Clean existing conduit, without conductors, with a mandrel or cylindrical wire brush, and blow out with compressed air before incorporating into a new system. Where new junction boxes are placed in existing conduit runs, fit the conduit as specified in (h) above. Install bushings as required by 00960.42(g).

(k) Conduit in or on Structures - Install conduit in or on structures according to the plans and Section 00583. Use approved expansion devices at all expansion joints in or on a structure. Install Type "AX" conduit expansion joints with bonding jumper where conduits cross bridge and other expansion joints. The expansion joints shall permit a 8 inch conduit movement on steel structures and a 4 inch conduit movement on concrete structures. Expansion-deflection fittings shall consist of two silicon bronze couplings and a molded neoprene sleeve with a bonding jumper passing through a separate waterproof compartment. Fittings shall permit at least 3/4 inch expansion and contraction and a 3/4-inch deflection without deformation.

(l) Installation by Plowing or Horizontal Directional Drilling - High-density polyethylene (HDPE) conduit conforming to 02920.11(c) may be used for [horizontal directional drilling and plowing installations](#). [Plowing is only allowed if shown](#). [If rigid metallic or rigid nonmetallic are used, verify the joints have not separated by pulling a mandrel through after installation](#). Use 3 feet minimum cover [for drilling installations regardless of the type of conduit installed](#).

00960.43 Foundations:

(a) General - Construct foundations for signal and luminaire poles, pedestals, posts, towers, cabinets and tower service pads of concrete ($f'_c = 3,300$ psi) according to the applicable portions of Section 00440 or 00540 as shown or specified. Place concrete:

- With a continuous pour
- To the elevation shown or directed
- With conduit ends and anchor bolts held securely in proper vertical position, to proper height, with a manufacturer's recommended template until the concrete sets

Make no adjustment of anchor bolts after concrete has set. Any adjustment made may be cause for rejection of the foundation.

Maintain rebar clearances during concrete pour.

Set forms square and true to line and grade. Construct forms of rigid materials that remain in position until the concrete has set. In foundations for signal, luminaire and high-mast luminaire poles, use a steel template to accurately locate the anchor bolts and hold them plumb and in proper alignment. Out-of-position anchor bolts and anchor bolts installed more than 1:40 (H:V) out of plumb are cause for rejection of the foundation. Field bending of anchor bolts and field modification of the base plate are not allowed.

Finish tops of foundations to roadway, sidewalk or curb grade, or as directed.

Finish exposed concrete foundations to present a smooth, neat appearance. Fill all holes.

Where breakaway bases are specified, the post stub projection shall not exceed the limits shown.

Where obstructions prevent the construction of planned foundations, construct the foundations in the location directed. Any extra cost due to the site change will be paid according to Section 00196.

If it is determined that foundations must extend deeper than shown, the extra foundation depth will be paid according to Section 00196.

(b) Treatment for Aluminum-Concrete Contact - If aluminum poles are used, furnish anchor bolts, nuts, and washers as specified for steel poles.

(c) Pre-cast Footings - Pre-cast footings will only be accepted for those projects where they have been approved and are clearly indicated on the plans set.

Installation and backfill of pre-cast concrete pole bases shall be done only with the inspector present. Any pre-cast concrete pole bases that are installed without the Inspector present shall be removed by the Contractor and reinstalled and back-filled with the Inspector present at no additional expense to City.

Installation of pre-cast concrete pole bases shall be on undisturbed native materials. All disturbed material shall be removed from the excavation of the pole base. Over excavation shall be replaced by class 2200 concrete backfill at no additional expense to the City.

Separate the aluminum from the concrete with one layer of 30 pound non-perforated, asphalt-saturated felt meeting the requirements of 02920.31(b). Neatly trim the felt pad to the size and shape of the base contact surface.

00960.44 Junction Boxes:

(a) General - Install junction boxes at the approximate locations shown on the plans, or no more than 300 feet apart. The Contractor may, at no additional cost to the City, install additional junction boxes to facilitate the work.

Size all junction boxes as required by the NEC for the number and size of conductors to be placed in the box. Sizes of junction boxes shown on the plans or in the Special Provisions are inside dimensions.

The tops of junction boxes installed in the ground or in sidewalk areas shall be flush with the surrounding grade or top of curb. Where practical, place pull boxes shown behind curbs against the back of the curb. If installed in the roadway or shoulder, leave the top of junction box about 1/2 inch below the pavement surface.

In boxes having an open bottom, construct a sump of reasonably well graded 3/4 inch - 0 crushed gravel, 12 inches deep covering the approximate area of the box. Do not install conductors until the sump has been constructed. All conduits shall have 10 inch clearance to the lid after the junction box is installed.

Bond all metal junction boxes and covers to form a continuous system with metallic conduit, grounding wire, metal standards and controller cabinets. Leave enough slack in the bond wire to the cover to allow complete removal of the cover.

(b) Junction Box Locations:

If junction boxes are installed in unpaved areas, install a portland cement concrete apron even if not shown.

00960.45 Cable and Wire:

(a) General - Arrange wiring neatly within cabinets and junction boxes. Use approved lubricants when inserting conductors in conduit. Before pulling wires through underground conduit runs, blow the conduit out with 120 cubic feet per second compressed air. Prevent damage to the insulation when installing wire.

Before cable installation, clean all existing and new conduit with an approved cylindrical mandrel of the proper size for that conduit and blow out with compressed air. Mechanical pulling methods may be used for conduit cleaning.

Do not use tapes, straps, ties or other binding materials to bundle single conductors or cables together inside conduits or poles. Bundling of conductors or cables will be permitted at the terminating end points for pulling only.

Install pre-wired factory equipment according to the manufacturer's instructions.

Pull all wire on a straight line with the conduit opening to prevent damage to insulation. If pulls are made with poles or controller cabinet in place, use a pulley device to achieve a straight pull.

Use spade-type pressure connectors to connect all traffic signal conductors to terminal screws in cabinets.

00960.46 Metal Poles:

(a) General - Metal poles include towers, mast arm poles, strain poles, pedestals, posts, upsweep arms, mast arms, luminaire arms and necessary mounting appurtenances. The fabrication of metal poles from steel and other metals shall comply with all applicable portions of 02920.31 and AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. before the pole is placed. Do not erect poles until the Engineer has made a visual inspection of pole welding.

Furnish steel or aluminum poles as shown or specified. Luminaire poles may be of different material and design than traffic signal poles, but poles for similar use must be of same material and design.

Fabricate entrance openings in metal poles and arms, including handholes, before galvanizing, except as shown for mounting traffic signal material.

City of Portland Signals and Streetlighting personnel will mark traffic signal pole locations in the field.

(b) Design - All metal poles with self-supporting upsweep arms shall be designed similar to details shown on the plans.

(c) Pole Height - Before poles are ordered, the Engineer will check the pole heights in the field and verify that the specified luminaire mounting heights above pavement are provided. The length of upsweep bracket arms shall be as shown in the Metal Light Pole Table or on the plans. Height of traffic signal poles shall be as shown or specified. Height of poles requiring slip plate bases is the length of shaft above the slip plate.

(d) Mast Arm - Install mast arms for traffic signals and signs according to details provided by the manufacturer. Mounting appurtenances shall be the proper type and size to correctly fit the pole furnished, or as shown. Mast arms shall be self-supporting without tie rods, or braces. Mast arms and risers shall be tapered octagonal tubes conforming to the City's design standards

All mast arms shall allow wiring entrances directly into the pole from inside the mast arm.

(e) Luminaire Arm - The luminaire end of the arm shall be level when loaded to design weight. Use a bolted, flange type connection to join the upsweep arm to the pole. The connection shall be raintight and shall develop the strength of the arm. The mast arm rise shall be according to the Metal Light Pole Table, or as shown or specified. All luminaire arms shall allow wiring entrances directly into the pole from inside the mast arm.

Arms shall be self-supporting without tie rods, or braces. Measure upsweep rise from the point of attachment to the pole to the end tangent portion of the arm. Arms shall be tapered and either round, octagonal, or elliptical, if similar in design to those shown on the plans.

All arms shall allow for wiring entrances directly into the pole from inside the arm.

All pole bracket attachments for mounting upsweep arms shall have reamed, smooth ends.

The nominal mounting height (MH) shown in the Metal Light Pole Table or on the plans is the distance between the roadway at the edge of the pavement and the luminaire. This height may vary plus or minus 1 foot.

(f) Deflection - The horizontal dead load deflection at the top of the poles shall not exceed 1% of the pole length (2% for strain poles).

(g) Deviation from Straightness - After the poles are delivered to the jobsite, and before they are erected on the foundations, the Contractor may be required to check any or all poles for deviation from straightness according to the following:

(1) Deviation in One Plane and One Direction Only - A straight line joining the surface of the pole at the base and the same surface of the pole at the top shall not be more than 1/2 inch from the surface of the pole for each 10 feet of length from the closest of these points. The opposite surface shall meet the same requirement.

(2) Deviation in Any Plane - A straight line connecting the midpoint of the pole at the base, with the midpoint at the top, shall not pass through the surface of the pole at any intermediate point.

Any pole not meeting these requirements will be rejected. If more than 25% of the poles fail to meet these requirements, sufficient cause exists to reject the entire shipment of poles for the Project.

(h) Erecting Metal Poles:

(1) General - Erect metal poles and towers on concrete foundations and according to the recommendations of the pole manufacturer and as shown. Exercise reasonable care to prevent marking the finish and damaging poles and towers.

Install all joint traffic signal and illumination poles so the distance from the pavement to the light center is as shown or specified. Use the same tapered design for traffic signal and street light arms.

Bolt protrusion on slip base poles shall not interfere with the breakaway action of pole. File sharp edges smooth, and paint the top of any steel bolt that has been cut off.

Steel Strain Poles shall be raked away from the resultant load before loading. After all appurtenances have been attached, the pole will be plumb or slightly raked away from the load. A 1 inch wide weep channel shall be provided on the lowest face of the grout pad.

Mast Arm Poles shall be raked away from the resultant load before loading. After all appurtenances have been attached, the pole will be plumb or slightly raked away from the load. A 1 inch wide weep channel shall be provided on the lowest face of the grout pad.

Pipe Post and Frangible Base Pedestals shall be provided with a 1 inch wide weep channel on the lowest face of the grout pad.

Street light poles shall be provided with a short section of 1/2 inch diameter plastic pipe as a weep channel on the lowest face of the grout pad.

Dry-pack-non-shrink mortar shall be placed as grout material under the pole base plates to be completely fill the space under the base plate, castings (where applicable), and around the conduits and ground rod. Dry-pack non-shrink mortar shall consist of 1:3 mixture of cement and fine sand with just enough water so that the mixture will stick together when molded into a ball by hand and will not exude moisture when so pressed.

(2) Repair Damaged Finish - Repair damaged galvanizing or other finish as approved. Apply cold galvanizing to 4 inch diameter poles after cutting threads.

(3) Assembly of Supports and Bolt Tightening - Nuts shall have full thread engagement.

Furnish, at no additional compensation, a calibrated torque wrench of a capacity appropriate to the size and type of the bolts being tightened. Confirm the accuracy of the calibrated torque wrench through calibration by an approved independent testing agency at least one a year.

a. Anchor Bolts for Signal Supports, Fixed Base Luminaire Supports, and High Mast Luminaire (Tower) Supports - After foundation concrete strength and curing requirements are satisfied and after inspection of the foundation, pole installation may begin.

Lubricate anchor rods and nuts according to 02560.70. Estimate the required rake, if any, and set the lubricated leveling nuts accordingly, so that when pole installation is complete and all appurtenances are installed on the pole, the top of the pole is plumb with the base of the pole.

Lift the pole into position on the leveling nuts and washers. Make sure all leveling nuts and washers are in full contact with the base plate.

Install washers and lubricated top nuts, and bring to a snug tight condition. Snug tight is defined as the condition when all plies of the connection are in firm contact, and can be obtained by the full effort of a worker on the end of a 12 inch long wrench. Several passes may be required to obtain uniform snug tightness.

When all anchor bolts are snug tight, proceed with installation of arms and other appurtenances, if not previously installed. When installation of arms and appurtenances is complete, and the pole is plumb as defined above, final anchor bolt tightening may begin. If the pole is not plumb, adjust as required and repeat snug tightening as described above. As a safety measure, provide crane support of the pole until anchor bolt tightening is completed.

Mark the position of each turned element (nut or bolt head) with a felt tip pen or similar marker. Rotate each top nut past snug tight by the amount shown in .d below. Several passes may be required to obtain uniform final tightness. "Cheater" bars or slugging wrenches are allowed if required for large diameter anchor bolts.

b. Anchor Bolts for Slip Base (Break-away) Luminaire Supports - After foundation concrete strength and curing requirements are satisfied and after inspection of the foundation, pole installation may begin.

Lubricate anchor rods and nuts according to 02560.70. Estimate the required rake, if any, and set the lubricated leveling nuts accordingly, so that when pole installation is complete and all appurtenances are installed on the pole, the top of the pole is plumb with the base of the pole.

Install the anchor plate on the leveling nuts and washers. Make sure all leveling nuts and washers are in full contact with base plate.

Install washers and lubricated top nuts, and bring to a snug tight condition. Snug tight is defined as the condition when all plies of the connection are in firm contact, and can be obtained by the full effort of a worker on the end of a 12 inch long wrench. Several passes may be required to obtain uniform snug tightness.

When all anchor bolts are snug tight, proceed with the "Slip Base Bolting Procedure" as shown on the plans. When the "Slip Base Bolting Procedure" is complete, final anchor bolt tightening may begin. As a safety measure, provide crane support of the pole until anchor bolt tightening is complete.

Mark the position of each turned element (nut or bolt head) with a felt tip pen or similar marker. Rotate the top nut of each anchor bolt past snug tight by the amount shown in .d below. Several passes may be required to obtain uniform final tightness. "Cheater" bars or slugging wrenches are allowed if required for large diameter anchor bolts.

c. High-Strength Bolts in Mast Arm-to-Pole Connections and Luminaire Arm-to-Pole Connections - Lubricate high-strength bolts according to 02560.70. Provide all high-strength bolts with hardened flat washers under the element turned during tightening.

If arms or appurtenances are attached after pole erection, support them until bolts are snug tight.

Install high-strength bolts to a snug tight condition. Snug tight is defined as the condition when all plies of the connection are in firm contact, and can be obtained by the full effort of a worker on the end of a 12 inch long wrench. Several passes may be required to obtain uniform snug tightness.

Mark the position of each turned element (nut or bolt head) with a felt tip pen or similar marker. Rotate each top nut past snug tight by the amount shown in .d below. Several passes may be required to obtain uniform final tightness.

d. Final Tightening - Required final tightening of anchor bolts and high-strength bolts is shown in the following Table:

Connection Type	Rotation Past Snug Tight
ASTM A 307 Anchor Bolts	30° (1/12 turn)
ASTM A 449 Anchor Bolts	60° (1/6 turn)
ASTM A 325 Arm Connection Bolts	60° (1/6 turn)

(5) Bolt Inspection - The Engineer will observe the installation and tightening operations to insure that proper procedures are followed. All inspections will be visual and no testing will be conducted.

00960.47 Wood Poles - Submit wood pole designs according to 00960.02 including proposed ANSI 05.1 wood pole Class, guy anchor and span wire designs, and pole setting depths.

00960.48 Coating - Coatings shall conform to all applicable portions of Section 00594. Do not paint equipment fabricated of aluminum, stainless steel, or hot-dipped galvanized material, except as shown or specified.

00960.49 Electrical Service:

(a) General - Service points shown on the plans are approximate only. The exact location will be determined in the field. If service equipment is to be installed on utility-owned poles, position and attach the service equipment as required by the serving utility. When the size of wire from the utility company's secondary to the disconnect circuit breaker is not shown on the plans, use the size specified by the NEC, but not less in current-carrying capacity than the disconnect circuit breaker rating. Do not use less than No. 6 AWG for the service conductor. Wiring connections to the terminal screws on the circuit breakers and contactors shall make full contact under the screw head. Install conduit and weather heads on the service pole as required by the local utility or as shown. Size and depth of power service conduit shall be as specified by the supplying power company responsible for maintaining the conduit.

Where eyebolts are to be used on signal or illumination poles to receive overhead power service, determine from the local serving utility the direction the eyebolt should face.

Equip each service cabinet with a solid copper neutral bus and the number and size of switches or circuit breakers shown or specified. Install all overcurrent protection and relays as shown and according to the applicable portions of the NEC. Notify the local serving utility before making any contacts to utility poles.

| **Meter bases shall not be installed.**

(b) Circuit Breakers - Provide circuit breakers of the rating shown or specified and meeting the requirements of 02920.41.

00960.50 Grounding and Bonding:

(a) General - Make all conduit, metal poles, grounding wire, metallic junction boxes, metallic junction box covers and cabinets mechanically and electrically secure to form a continuous, effectively grounded system. Bond together all rigid steel conduit ends that terminate at the same location. Bond the copper grounding electrode conductor between the metal poles to the grounding rod at each foundation. Use stranded conductors for all ground and bond wires.

| **Ground Rods shall be driven diagonally in all pole and controller foundations.**

(b) Ground Rods - Construct accessible grounding conditions with electrodes of at least 5/8 inch x 8 foot nonrusting, copper covered, steel ground rods with bronze grounding wire clamps. Drive ground rods into the ground with the top about 6 inches below the finished grade at the ground rod locations. Install a separate ground rod for each electrical system that originates from a separate power source.

If approved, grounding rods may be driven diagonally. Where rock prevents full length driving, if approved, a buried galvanized iron or copper plate may be installed at the bottom of the concrete foundation hole. The plate shall be at least 2 foot square and 1/4 inch thick.

If resistance to ground is greater than 25 Ω , furnish and install a second ground rod, at no additional expense to the [City](#). Place electrodes at least 6 feet apart.

If resistance to ground is greater than 25 Ω after a second rod is driven, additional grounding methods, as approved, will be paid as Extra Work according to 00196.

Use No. 6 AWG copper wire to connect the ground rod to the electrical system.

(c) Services and Cabinets - Ground the neutral conductor, the control cabinets, and the metal base to [the grounding electrode system](#). [The ground rod for the service shall be in addition to the ground rod for a steel pole.](#)

Instead of placing the ground rod outside the traffic signal controller cabinet foundation, the ground rod shall be placed within the cabinet base opening.

(d) Structure Mounted Poles and Cabinets - Ground all poles and cabinets mounted on structures or walls to a common ground rod at the end of the structure. Ground the system at the first convenient acceptable location off the structure.

(e) Metal Poles - Install a ground rod at each pole, pedestal, or tower foundation. At each pole or tower location, supply and install a grounding electrode conductor from a lug inside the pole or tower to the ground rod clamp at the ground rod. Bond all conduit within the pole or tower together and to the ground rod. Use No. 6 AWG copper bond wire.

[Each metal pole shall be bonded to all attached messenger cable by means of a bond wire from a pressure clamp on the cable to a grounding bushing outside of and on the bottom of the terminal cabinet or attached to the pole if there is no terminal can. Do not take the bond wire inside the cabinet.](#)

In sidewalk or other areas where the ground rod cannot be made accessible, the ground rod may be driven diagonally through the foundations of fixed anchor base poles. If this method is used, drive the ground rod at least 4 feet into earth and leave at least 3 inches exposed through the top of the foundation. Bend the rod so that the exposed end is vertical and near the center of the pole. Connect the steel reinforcing cage to the ground rod using a No. 6 AWG copper wire. Securely clamp the wire to the reinforcing steel, through the ground rod clamp, and to the pole grounding lug. Do not use this method on slip base poles.

On the inside of tower shafts, weld a 1/2 inch, Type 308, 309, or 310 threaded stainless steel stud for a grounding lug. Locate the grounding lug 90° from, and level with, the bottom of the handhole.

For slip base poles, the grounding wire shall not intrude into the slip plane. Instead, run a bond wire from the grounding electrode to a 1/2 inch, Type 308, 309 or 310 threaded stainless steel stud welded to the bottom base slip plate.

For standard four-bolt anchor base poles, provide a 1/2 inch, Type 308, 309 or 310 stainless steel stud on the inside of the shaft. Locate the stud directly opposite and level with the handhole in the pole. Attach grounding electrode conductors and bonding conductors to the stud with a grounding wire clamp, "acorn style", similar to what is used with ground rods in (b) above.

(f) Wood Poles - On wood poles, ground all metallic conduit, messenger cable, terminal cabinet, and other equipment.

(g) Nonmetallic Conduit - In all nonmetallic type conduit, run a bond/ground wire continuously between all poles, pedestals, posts, and cabinets. Bond/ground wire shall be a green No. 8 XHHW copper wire or as required by NEC, or as shown. Bond wires are not required:

- At traffic signal installations when the conduit contains only loop feeders, emergency vehicle preemption cables, or DC interconnect cable
- Where nonmetallic conduit is to be installed for future conductors
- Where only low voltage DC currents are present

00960.70 Electrical Energy - Obtain the required permits and have the power service inspected by the City. Notify the Engineer to arrange for the utility to make the electrical hookup. Power consumption for traffic signals and illumination shall be flat-rated.

Electrical energy costs to operate traffic signals and/or illumination will be billed to the City or those named in the construction agreement. Do not use for construction purposes electrical energy billed to the City or other agencies.

Section 00970 - Illumination

Description

00970.00 Scope - In addition to requirements of Section 00960, "Common Provisions for Highway Illumination and Traffic Signals", the following Specifications apply to illumination installations.

00970.03 Luminaire Submittal - Provide a sample luminaire for inspection and photometric testing if required. Sample luminaires may be considered as part of the shipment furnished for installation.

Construction

00970.41 Metal Light Pole or Tower Table - The metal light pole or high mast tower table for the Project can be found on the highway illumination plans.

00970.42 Cable and Wire - Use type XHHW stranded copper wire in all current-carrying conductors in raceways.

Support the conductors at the top of the pole using a flexible metal cable support grip to prevent insulation damage at the upsweep arm opening. When splicing into a new or existing circuit at a pole base (minimum wire length: 18 inches outside handhole), install a watertight, in-line fuseholder in the pole base for each ungrounded wire going up the pole. This fuseholder shall conform to the requirements of 02920.26 and be constructed so the wire to the ballast can be disconnected without cutting or disconnecting wiring at the ballast.

Use No. 10 AWG type XHHW wire from the control cabinet to the photoelectric relay.

00970.43 Photocontrol Electronic Relay - Equip the photocontrol electronic relay for either luminaire, wood pole or metal pole mounting as shown or specified.

Use a pole-top mounted, photocontrol electronic relay with twistlock plug where shown or specified. Furnish and install a pole-top, slip-fit adaptor with terminal board. Securely fasten the pole-top adaptor to the pole top with setscrew studs, and follow EEI-NEMA specifications for mounting tubeless control units. Mount the relay above adjacent light units, so the light sensitive element's surface is oriented to the northern sky. Mark the date of installation on the bottom of the photocontrol electronic relay.

00970.44 Luminaires - Level luminaires on the upsweep arms in both the transverse and the longitudinal direction, as recommended by the manufacturer.

On roadway grades greater than 4%, orient luminaires on the upsweep arm so that the light beams strike the pavement equidistant from the luminaire.

(a) Mounting Height - Mount luminaires at heights shown. Measure the nominal mounting height from the top of the nearest edge of pavement to be lighted to the center of the luminaire.

(b) Lamp Marking - Mark the month and year the lamp is installed on the lamp base dating system with a sharp instrument.

(c) Lamp Size and Identification Decals:

(1) Identification Decals for High-Intensity Discharge Lamps - Indicate the lamp size and type with a NEMA-approved decal on each luminaire as specified below. Apply decals on clean and prepared surfaces. Use decals that provide a durable, legible surface for the life of the luminaire, and:

- Are at least 3 inches square
- Are made of noncorrosive, pressure sensitive material
- Have a colored background with black numbers as shown in Table 00970-1

For pole mounted **cobrahead and shoebox style** luminaires, install the decals on the bottom side of the luminaire **so as to be readily visible from the ground**.

For wall-mounted luminaires, install the decals vertically on the luminaire housing or adjacent to the luminaire on the wall, as directed.

For pendant-mounted luminaires, install the decals horizontally on the ballast housing or externally at the top portion of the reflector if a remote ballast installation.

(2) Lamp Size and Identification Decal Code - Use the lamp size and color codes that conform to the following:

**Tables 00970-1 A and B - Lamp Decal Code
High Intensity Discharge Lamps**

TABLE 00970-1 A		TABLE 00970-1 B	
Lamp Wattage	Identifying Number	Lamp Type	Background Color
50	5	Clear Mercury	Blue (Light)
70	7	Phosphor-Coated Mercury	White
100	10	High Pressure Sodium	Gold - Yellow
150	15	Clear Metal Halide ¹	Red
200	20	Phosphor-Coated Metal Halide ¹	Green
250	25	Induction Lamp	Orange
400	40		

¹ In addition, metal halide lamp targets shall include a 1/2 inch wide by 3 inch long strip of pressure sensitive, flat top, wide angle reflective tape to show lamp burning position requirements. Apply tape 1/2 inch from the lamp size target as follows:

Lamp Burning Position	Target Color
Any Position	None
Base up to horizontal	None
Base down to horizontal	Gold
Position-oriented-mogul socket (POM)	Red

00970.45 Pole Identification - Identify [cobrahead and shoebox](#) luminaire poles with a numbered label corresponding to the pole numbers on the illumination plans. Labels shall:

- Be made of noncorrosive, pressure-sensitive material suitable for outdoor use and resistant to fading and abrasion
- Have blue or black numbers with a high-contrast colored background
- Have 1/4 inch block numbers at least 2 inches high
- The letter "C" shall be painted above the numerals.

Install labels on poles so they are visible from a passing vehicle.

00970.48 Coating:

(a) Poles - All light poles, mast arms, and associated hardware shall have a finish as indicated on the plans.

Galvanized and Aluminum poles and castings shall be cleaned with a solvent (xylene or MC thinner to remove any oils and contaminants, wiped dry, and sanded to abrade the surface prior to applying primer. The poles and castings shall be primed by the pole manufacturer with 3 mil DFT (dry film thickness) on all exterior surfaces with one coat of *Wasser MC-Ferrox B*, and allowed to cure for a minimum of 6 hours prior to applying the top coat.

The poles and castings shall have a field applied top coat with 3 mil DFT of *Wasser* paint in accordance with the manufacturer's recommendations and Steel Structure Painting Council SSPCPA-1 Good Painting practices. The top coat color shall be as indicated on the plan set. Current paint colors include:

- Transit Blue MC-Luster (W21.0233)
- Historic Black MC-Luster (W21.79)
- Portland Green MC-Luster (W21.0227)
- Gold MC-Luster (W21.0226)
- Cascade Green MC-Luster (W21.0225)
- Chinatown Red MC-Luster (W21.0261.4)
- Silver MC-Luster (W21.82.1)

| Post "WET PAINT" signs near each pole.

| Spray application will not be permitted at any time.

| **(b) Service Cabinets** - Pole mounted service cabinets shall be painted to match the pole.

| **(c) Reused Material** - Where the plans or specifications allow the reuse of certain materials, such materials shall be cleaned, shot or sand blasted to bare metal. All surfaces shall be clean, dry, sound, and free of all contaminants. Existing unsound paint shall be scraped away by hand to bare metal; and any and all rust, dirt, debris, and unsound material shall be removed by hand with a wire brush and sandpaper. Remove oil or grease with solvent such as turpentine mineral spirits, or xylol in compliance with SSPC-SPI-63 Solvent Cleaning. Care should be taken to ensure a clean, smooth, sound continuous surface for painting.

| All surfaces which have been cleaned down to bare metal should be primed within 8 hours when practical, but in any event not later than 24 hours before any visible detrimental rusting can occur.

| After cleaning and priming the reused equipment shall be painted as specified for new equipment.

Maintenance

00970.60 Maintaining Existing and Temporary Illumination Systems - Keep existing illumination systems (street lighting), their approved temporary replacements, or temporary construction lighting in effective operation for the benefit of the traveling public during progress of the work, except when shutdown is permitted to allow alteration or final removal of the systems. Lighting system shutdowns shall not interfere with the regular lighting schedule unless otherwise permitted. Notify the Engineer before performing any work on existing systems.

Determine the exact location of existing conduit runs and pull boxes before using equipment that may damage such facilities or interfere with any system.

| If damage is caused by the Contractor's operations, repair or replace damaged facilities promptly at no additional compensation according to [00170.80](#). If the Contractor fails to perform the required repairs or replacements, the City retains the right to perform this work according to [00170.80\(d\)](#).

Where roadways are to remain open to traffic and existing lighting systems are to be modified, keep the existing systems in operation until the final connection to the modified circuit is made. The modified circuit is to be complete and operating by nightfall of the same day the existing system is disconnected.

Keep temporary construction lighting installations in effective operation until they are no longer required for the protection of the traveling public.

Finishing and Testing

00970.70 Field Test - After the lighting systems has been installed and energized, and prior to final acceptance, operate the system for seven (7) days under normal conditions (off during the day, on at night). Notify Street Lighting Inspector forty eight hours in advance of start of the seven day test.

Measurement

00970.80 General - No measurement of quantities will be made for this work. If plan changes are ordered, or the field-verified pole or arm lengths increase or decrease for lighting poles and arms, adjustment will be made according to 00970.91.

The estimated quantities of lighting poles and arms will be listed in the Special Provisions for the purpose of providing a basis for adjustment. No adjustment in the Contract lump sum amount will be made, except as provided above. Any adjustment in the Contract lump sum amount will be made according to 00190.10(f)

Payment

00970.90 Lump Sum Basis - Payment will be made at the Contract lump sum amount for the following items:

Pay Item	Unit of Measurement
(a) Pole Foundations.....	Lump Sum
(b) Lighting Poles, Fixed Base	Lump Sum
(c) Lighting Poles, Slip Base	Lump Sum
(d) Lighting Pole Arms.....	Lump Sum
(e) Luminaires, Lamps and Ballasts.....	Lump Sum
(f) Switching, Conduit, and Wiring.....	Lump Sum
(g) Refurbishing and Reinstalling Existing Illumination Systems ..	Lump Sum

Item (a) includes all concrete foundations for lighting poles.

Item (f) includes all switches, conduit, cabinets, wiring, delineators and other items required to construct the lighting system as specified.

Item (g) includes all refurbishing, reinstalling, and other work as specified and not included in the removal of existing illumination.

Labeling lights or poles will be considered incidental to the appropriate light or pole pay item.

Payment will be payment in full for furnishing and placing all materials, and furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

00970.91 Adjustments - In items (b), (c) and (d) no adjustment in payment will be made for increases or decreases of individual pole or arm lengths up to and including 3 feet.

Adjustment in payment for increases or decreases of individual pole or arm lengths more than 3 feet will be made only on the increased or decreased length more than 3 feet.

00970.92 Electrical Energy Costs - All electrical energy costs for the lighting systems or subsystems will be paid for by the City.

00970.93 Incidental Items - If shown or specified as part of the work under the pay items for concrete bridges or retaining walls, all conduit, junction boxes, cabinets and other items permanently encased within the concrete of bridges and retaining walls, as well as pole foundations incorporated in a bridge or wall, will be considered incidental to the work for those items. Include the cost of this work in those items.

Section 00980 - Sign Illumination

Description

00980.00 Scope - This work consists of furnishing and installing all necessary conduits, junction boxes, cabinets, wiring and other equipment as shown and specified for sign illumination.

00980.01 Regulations and Code - All electrical equipment and work shall conform to 00960.01.

00980.02 Equipment Lists and Drawings - Submit required equipment lists, working drawings and as-constructed drawings according to 00960.02.

Submit six copies of isocandela diagrams for each different size sign to be illuminated. Provide data in tabular form showing the luminance levels, in lx (footcandles), at 1 foot intervals in both the horizontal and vertical directions over the entire sign surface. Submit from the luminaire manufacturer details of lamp socket position with respect to lamps and refractors furnished, for each type of luminaire specified.

Complete description data is required including noted exclusions for any of the luminaires specified.

00980.03 Luminaire Submittals - If directed, provide a sample luminaire for inspection and photometric testing. Sample luminaires may be considered as part of the shipment furnished for installation.

Materials

00980.10 General - Materials shall meet the following requirements:

Ballasts	02920.52
Cabinets	02920.40
Cable and wire	02920.20 -.28
Conduit	02920.10 -.12
Control devices	02920.42
Electrical splice materials	02920.25
Junction boxes	02920.13
Lamps	02920.50
Wood poles	02920.30

All conduit, junction boxes, and cabinets for sign illumination circuits that are also used for roadway illumination are discussed in Section 00960 and Section 00970.

00980.11 Sign Luminaire Ballasts - Provide high-intensity discharge ballasts of the type and wattage shown or specified.

00980.12 Sign Luminaires:

(a) General - Bottom-mount all sign luminaires as shown.

Electrical components of the sign luminaires shall bear the label of approval by the Underwriters' Laboratories, Inc.

(b) High Intensity Discharge Sign Luminaires - Fabricate high-intensity discharge sign luminaire housings of either cast aluminum, 0.80 inch minimum die-formed aluminum, or 0.064 inch minimum extruded aluminum. The reflector shall be die-formed, anodized specular aluminum. Fabricate lens frames of cast or extruded aluminum. Mount the refractor in the lens frame assembly and hinge to the luminaire housing. The refractor and lens frame assembly, when closed, shall exert even pressure against a gasket seat. Furnish gaskets of material capable of withstanding temperatures encountered. Securely seat the gasket in place. Glassware shall be thermal, shock-resistant borosilicate glass.

Provide stainless steel or corrosion-resistant fasteners. Protect all aluminum surfaces with either an anodized finish or an approved aluminum paint finish.

Mount ballasts integrally with the luminaire. Mount luminaires on the luminaire support arms as shown and with a low profile, not to exceed 11 inches in height when mounted. Shield luminaires so no light will be visible from behind the luminaire.

Determine, provide and install the number of luminaires needed to illuminate each sign.

The total nominal lamp power (not including ballast) for each sign length shall not exceed the following:

Sign Length, L	Maximum Lamp Power (watts)
Less than 9' 0"	250
9' 0" to less than 17' 0"	500
17' 0" to less than 26' 0"	750
26' 0" to 35' 0"	1000

Use only 100, 175 or 250 W phosphor coated mercury vapor lamps. When necessary, adjust spacing of the luminaires and/or safety rail posts to prevent interference.

The photometric performance of mercury vapor luminaires equipped with a 4000, 8000, or 11 500 lm lamp, with the light center 12 inches below and 48 inches in front of the sign (54 inches when sign height is equal to, or greater than, 7' 0"), shall meet the following criteria on each sign:

Average Horizontal Footcandles, minimum	35.0
Footcandles, minimum	8.5
Maximum/minimum uniformity	6.0:1 or less
Maximum gradient	1.7:1 or less
Uniformity of illumination, minimum	60%

Maximum gradient is the ratio of the illumination value on any 1 square foot area of the sign to the value on any adjacent 1 square foot.

$$\text{Uniformity of Illumination} = 1 - \frac{\text{mean deviation}}{\text{average FC}} \times 100\%$$

$$\text{Where mean deviation} = \frac{\sum \text{ABS} (\text{FC}_{\text{point}} - \text{FC}_{\text{ave}})}{\text{number of points}}$$

00980.13 Sign Luminaire Identification Decals for High-Intensity Discharge Lamps - Provide identification decals meeting the requirements of 00970.44(c-1) and (c-2). Install decals on the bottom side of luminaires to provide good visibility from the ground.

Construction

00980.40 General - Furnish and place miscellaneous materials not shown or specified, but required to complete the illumination installation, as shown or specified. Such materials will be approved as suitable for the use intended.

Construct and test according to this Section and Sections 00960 and 00970.

00980.41 Installation of Wiring and Conduit - Install all sign illumination wiring, both above and below ground, according to the NEC with type and wire size as shown or specified. Install all conduits according to Section 00970. All conduit, junction boxes and cabinets for sign illumination circuits, which are used for roadway illumination, are covered under Section 00960 and Section 00970.

Use No. 10 AWG type XHHW wire from the sign disconnect breakers to the sign luminaires.

Install rigid metal or intermediate metal steel conduit on the sign structure with flexible conduit connections to the junction box on the pipe support and at the end connection to the sign luminaires. The minimum size of any type of conduit to be installed shall be 3/4 inch.

Install the power feed conductors from the service pole to the sign structures as shown.

00980.42 Grounding and Bonding - Ground and bond according to 00960.50, except provide a handhole in the sign support column to provide access to the grounding conductor and grounding lug. Ground metal sign support structures using the same method as for metal light poles.

00980.43 Sign Control Equipment - Install electrical sign disconnect circuit breakers of the size shown in disconnect cabinets on sign support structures or where shown, or provide one circuit breaker for each overhead sign and all ballasts for that sign.

00980.44 Cabinets - Mount the sign control cabinet on the support column on the side away from traffic.

00980.45 Galvanizing - Galvanize all components of steel sign illumination equipment after fabrication and before assembly. Galvanize according to ASTM A 123/A 123M.

Measurement

00980.80 Lump Sum Basis - There will be no separate measurement for work done under this Section.

Payment

00980.90 General - Payment will be made at the Contract lump sum amount for the item "Sign Illumination Equipment". Payment will be payment in full for all equipment labor and incidentals necessary to complete the work.

00980.91 Incidental Items - If shown or specified as part of the work under the pay items for concrete bridges or retaining walls, all conduit junction boxes, cabinets and other items permanently encased within the concrete of bridges and retaining walls, as well as pole foundations incorporated in a bridge or wall, will be considered Incidental to the work for those items.

Section 00990 - Traffic Signals

Description

00990.00 Scope - In addition to requirements of Section 00960, install traffic signals according to the Manual on Uniform Traffic Control Devices with Oregon Supplements, Institute of Traffic Engineers standards, and the following Specifications.

Materials

00990.10 General - Materials required for completion of the installation will be shown or specified. Materials shall meet the requirements of the following:

Aluminum poles	02920.31
Anchor bolts.....	02920.34
Audible pedestrian signal.....	02920.66
Ballasts	02920.52
Cabinets	02920.40
Cable and wire.....	02920.20 -.23
Circuit breakers.....	02920.41
Conduit	02920.10 -.12
Detection devices	02920.45
Electrical splice materials	02920.25
Flasher mechanism (remote from controller cabinet)	02920.42
Frangible bases	02920.33
Illumination control devices.....	02920.41
Inductive loop feeder cable	02920.22(d)
Inductive loop wire	02920.23(b)
Interior illumination signs	02920.61
Junction boxes.....	02920.13
Lamps.....	02920.50 -.51
Luminaires	02920.53
Pedestrian signal heads and push buttons.....	02920.65
Signal heads	02920.64
Signal indication devices	02920.60
Steel poles	02920.31
Steel towers	02920.32
Traffic signal control devices	02920.42
Wood poles.....	02920.30

Construction

00990.40 Cable and Wire:

(a) General - Install wire and cable according to 00961.45 and the following:

Install wire between pole or pedestal bases and terminating points without splicing. Install control cable from signal spans to terminal cabinets without splicing. Do not use junction boxes for splicing, except for loop wire splicing of loop wires to loop feeder cables.

Leave slack in each wire and cable at each pull box, pole, and controller cabinet as follows:

- 2 feet in pull boxes and poles
- 6 feet in controller cabinets
- 6 feet in the first pull box nearest the controller

Control cable (PC cable) shall be No. 14 stranded copper conductors and shall be used for all intersection wiring inside poles and conduits. Individual wires shall not be used except for power service.

(b) Control Cable Attachment - Use self-locking plastic straps to attach control cables to the messenger cable. Do not allow gaps between the control cable and the messenger cable. After tightening, trim all excess material neatly.

Provide sufficient conductors to perform the functional operation shown. Tape the ends of extra conductors with insulating tape. Where the plans omit necessary wiring to provide the operation shown, furnish and install wire as needed to meet the operational requirements shown or specified. The number of conductors in a cable may be greater than that shown.

(c) Messenger Cable - Attach messenger cable at least 6 inches below the top of the pole, unless otherwise shown or specified.

Use an eyebolt and StrandVise® to attach messenger cable to City-owned wood poles. Install a 2" x2" washer between the eye and the pole.

Make attachments to utility-owned poles according to the local utility company's regulations and under its supervision.

Do not weld eyebolts to poles. Install the eyebolts through the entire pole. Pull the shoulder of the eye tight against the front face of the pole.

(d) Tether and Stabilizer Cable - Install tether and stabilizer cables on traffic signal spans where shown. Tighten cables to limit signal and sign movement. Install City-furnished S-hooks between the eyebolt and turnbuckle.

(e) Interconnect Cable:

(1) Splices or breaks in the interconnect cable and shield will not be permitted except as shown.

Use terminal cabinets for aerial pole entrance of interconnect cable.

(2) Interconnect Cable Installation:

All cable installation shall meet the requirements of the Standard Specifications, the National Electric Code, and the National Electrical Safety Code, and will be approved by the Engineer, where applicable. Use approved cable guides, feeders, shoes and bushings to prevent damage to the cable during installation. Do not pull cable over edges or corners, over or around obstructions or through unnecessary curves or bends. Cable shall enter the box or cabinet directly from the reel or storage stack. Pull directly out of the next downstream box or cabinet.

Match the sag as closely as possible with wires already on poles to minimize movement in windstorms and conflict with adjacent wires.

Use a grip to grip the jacketed messenger when pulling and tensioning. Pull and tension cable without damaging the jacket. When separating the messenger on figure-8 cable from the jacketed conductor assembly for dead-ending or splicing, split the web using approved tools designed for this task.

At corners and run ends, dead-end the messenger strand with approved automatic StrandVises® or similar devices. Cut the strand and remove the jacket, exposing enough strand so that the ends of the strands coming through the chucks of both vises can be overlapped and bonded together to form a continuous ground. Use a one-bolt guy clamp to bond the strand ends together. Where figure-8 cable is used, remove existing unused messenger cable.

In transition areas from overhead to underground, continue the aerial cable underground to the nearest termination panel. If figure-8 type cable is used for overhead locations, strip the messenger wire from the cable, using approved tools, where the cable is within a conduit, pole or cabinet.

Cable in trunk runs may be installed by hand or by mechanical methods, as approved. Trunk runs are those lengths of conduit that will have 25 or more pairs of interconnect cable installed. Install all other cable by hand methods only.

Before installing cable, provide the Engineer with one copy of the cable manufacturer's recommended and maximum pulling tensions for each cable type. Specify these pulling tensions for both pulling from the cable's conductors and for pulling from the cable's outer jacket.

When installing cable using a pulling eye, do not exceed the cable manufacturer's maximum recommended pulling tension for pulling from the pulling eye. When installing cable using a pulling sock over the outer jacket, do not exceed the cable manufacturer's maximum recommended pulling tension for pulling by the outer jacket, or 80% of the manufacturer's maximum recommended pulling tension for pulling by a pulling eye, whichever is smaller. Use an approved dynamometer to ensure that the maximum allowable pulling tension is not exceeded during installation.

Run all cable continuously without splicing from termination point to termination point. Splicing cable at any location other than shown is not permitted. Splicing cable in conduit, junction boxes, underground vaults, manholes, or handholes is not permitted.

Do not pull cable through any intermediate junction box, handhole, or any other opening in the conduit, unless shown or approved. Pull the necessary length of cable to be installed from one junction box, handhole, controller cabinet, or terminal cabinet to the immediate next downstream box, handhole, or cabinet. Carefully store the remaining length of cable to be installed in the next conduit in a manner that is not hazardous to pedestrian or vehicular traffic, and protects the cable from damage. Store the cable so that it can be safely pulled into the next conduit. Obtain the Engineer's approval of the storage methods to be used.

Label all interconnect cable with approved bronze or plastic labels, permanently and ruggedly attached. The labels shall be embossed with the cable identification number. Additionally, labels used on utility facilities shall bear the legend "TRAFFIC SIGNAL". Label all ends of cables. Label all overhead cable in each direction away from the point of attachment, 2 feet from utility poles. Do not install labels until the Engineer approves the labels and attachment mechanism. Label all cables in the interconnect terminal cabinets and at terminal panel locations. In all junction boxes, interconnect terminal cabinets, auxiliary cabinets, controller cabinets, and terminal cabinets, permanently attach 10 inch lengths of 1 inch wide light blue or royal blue plastic surveyor's marker tape, or equivalent, to all interconnect cable. No adhesive marker tape or other such malarkey will be permitted.

Where the Contractor is to remove or install interconnect cable in conduit containing service wiring and/or field wiring, whether or not the plans indicate service and/or field wiring in that conduit, use the following procedure, unless another procedure is approved:

- a.** Disconnect all necessary service and/or field wiring.
- b.** Furnish, install and maintain all traffic control devices and procedures.
- c.** Remove all cable and wiring from the conduit, being careful not to damage any wiring. Replace to the Engineer's satisfaction all wiring to be reinstalled that is damaged by the Contractor, at no expense to the City. Any wiring, except solid-conductor ground wiring, not suitable for reinstallation that has been removed by the Contractor with all reasonable care, as determined by the Engineer, shall be replaced to the Engineer's satisfaction and paid for as Extra Work.
- d.** Replace all solid-conductor ground wiring removed from conduit with No. 6 bare or green THWN stranded copper wire.
- e.** Clean the conduit as described in 00961.45(a).
- f.** Reconnect all wiring.

Protect existing cables or equipment from damage as required by 00150.50(c) and 00170.80. Should existing cables or equipment be damaged by the Contractor's operations, immediately notify the Engineer and the affected owner. The cost to repair damages caused by the Contractor's actions may be withheld according to 00195.50(m).

(3) Interconnect Cable Testing - Test interconnect cable according to 00990.70(i).

00990.41 Cabinet:

(a) Signal Circuit Overhead Terminal Cabinets:

(1) General - All wires or cables, which begin or terminate in a terminal cabinet, shall be made up using double pressure type, terminal blocks utilizing a pressure spring. The terminal blocks shall have 6 or 12 feed through terminals and shall be of unit construction, not modular. The wiring channel and clamp pieces of the connector shall be copper.

Where a terminal cabinet or pole base is detailed in a terminal cabinet or pole base wiring diagram, use the exact number of 6 or 12 terminal strips shown. Where a straight through connection of a cable is shown as a dot, provide and install terminal strips of adequate size to accommodate the number of wires in the cable.

Individual wires shall be stripped to between 1/2" to 3/4". The strands shall be reformed into a tight bundle before insertion into the block. Where two or three wires enter a block on the same side, the bare strands of wire shall be twisted together before insertion. The wires shall be inserted to the stop. No more than three wires shall be inserted into one side of any one terminal. The terminal screw shall be tightened to a torque of between 30 and 35 inch pounds.

The terminal strips shall not be attached to the cabinet and there shall be enough slack left in the cables or wires to allow the terminal strips to be completely removed without disconnecting any conductors.

All wires and cables shall be connected in accordance with the color code specified on the plans.

All spare wires shall have their ends taped and shall not be used as extra neutral conductors.

Splicing of wires or cables will not be permitted in conduits or outside of terminal cabinets, condulets, steel poles, pole bases, signal heads or pull boxes.)

(2) Existing Terminal Cabinet - If it is determined that existing terminal cabinets need to be replaced, and this work is not covered by the Contract Documents, furnish and install the cabinet with the required number of sectional double terminals on an Extra Work basis according to Section 00196.

(b) Remote Detector Amplifier Cabinet - The minimum size for cabinets shall be:

Number of Detector Amplifiers	Height	Width	Depth	Number of Shelves
4 or less	16"	12"	10"	1
5 to 8	20"	16"	10"	2

All amplifier cabinets shall contain:

- A 20A circuit breaker for power disconnect
- A 1/2 inch, screened drain hole in the bottom. Use a fine mesh screen made of either brass or stainless steel, soldered or spot-welded in place.
- An adequate number of double-barrier screw terminals, as determined by the Contractor, based on the number of field connections required and cable harness connections

Crimp and solder all spade connectors and wires connecting the input panel to the input files.

Submit the cabinets with amplifiers for visual inspection and testing.

The lock for the cabinet shall be Best Co. padlock 21B722-L-606 with a "Green" core for the cabinet.

(c) Flasher Cabinet - The cabinet shall be 14" high x 10" wide x 7" deep. The cabinet shall have brackets which extend 1 1/2 inches above and below the cabinet to allow the cabinet to be mounted with lag bolts or steel banding. Furnish a Best Co. padlock 21B722-L-606 with a "Green" core for the cabinet. The cabinet shall be equipped with a securely mounted Model 204 flasher. The cabinet shall contain double barrier type screw terminals with marker strips connected as follows:

Model 204 Flasher Pine Number	Terminal Circuits
11	AC+
10	AC-
7	LD Cut #1
8	LD Cut #2 Common
9	EQ GND

(d) Power Service Cabinet - A combination enclosed meter socket and main disconnect will not be required. Power consumption meters will not be required and shall not be installed on this project.

Furnish a Best Co. padlock 21B722-L-606 with a " Green" core for the service.)

(e) Cabinet Protection - Keep interiors of all cabinets clean and free of dust, dirt, moisture, and other foreign matter. In inclement weather, use tents to cover cabinets when doors are open. Vacuum and dry out all cabinets immediately before installing equipment unless otherwise directed. Correct any damage caused by dust, dirt, moisture or foreign matter at no cost to the City.

00990.42 Indication Equipment:

(a) Standard Vehicle Signal Heads - Standard traffic signal heads shall be one-way, three-section heads, adjustable through 360° about a vertical axis, and designed for the method of mounting shown or specified. Furnish heads complete, including lamps, lenses, LEDs modules, visors, reflectors, sockets, backboards and mounting appurtenances. Install all lamps with the open end of the horseshoe-shaped filament in the up position.

Vehicular signal heads shall be:

- Designed so they can be suspended from mast arms or span wires, or mounted on brackets or pedestals as required
- Equipped with positive lock rings and fittings designed to prevent the heads from turning due to external forces
- Equipped with all necessary appurtenances for the type of mounting required

Tighten all backboards and visors securely against the signal head.

For requirements relating to special vehicle signal heads (signal heads required to produce an indication other than those resulting from the use of standard red, yellow and green lenses) see the Special Provisions.

(b) LED Traffic Signal Head Retrofit Kits - Retrofit kits in new or existing heads shall fit into all types of 12 inch traffic signal heads without the need to modify the head. Mount the kit using the existing lens mounts. Kits are not required to fit 3M® optically programmed signal heads.

(c) Optically Programmed Vehicle Signals - Furnish and install complete, optically programmed vehicle signals that conform to all applicable portions of 00990.42(a). A complete vehicle signal includes the required number of signal sections with optical components, individual intensity control, cutaway visor, backboard and mounting hardware.

(1) Optical System - Optically programmed vehicle signals shall:

- Have lenses with a nominal diameter of 12 inch
- Use lamps of the type and wattage recommended by the signal manufacturer
- Permit selective programming of the visibility zone of the projected indication anywhere within 15° of the optical axis of each signal section
- Include an easily accessible visibility-limiting device that can be programmed to restrict the viewing area of the projected indication without the use of hoods or louvers

- Include an integral means for regulating the intensity of the projected indication as a function of the ambient light conditions. The reduction in lamp intensity shall be proportional to the reduction in ambient light within the following limitations:
 - If ambient light is 1,000 foot-candles or more, the lamp intensity shall be at least 97% of maximum.
 - If ambient light is 1 foot-candle or less, reduce the lamp intensity to approximately 15% of maximum.

(2) Installation - Provide a manufacturer-certified technical representative who shall:

- Program the visibility-limiting device as outlined by the signal manufacturer. The technical representative shall furnish all needed special materials
- Program the signals satisfactorily before placing the signal installation in operation

On programmed vehicle signals mounted on span wires, install washers on the pin that connects the signal hanger to the cable clamp. Install enough washers to limit the lateral movement of the hanger to a minimum.

(d) Pedestrian Signal Heads - All relevant portions of 00990.42(a) and 02920.65 apply to pedestrian signal heads.

(e) Flashing Beacon Signal Heads - Flashing beacons shall:

- Conform to all applicable portions of this subsection
- Be of single-section construction
- Be equipped for the type of mounting shown

Use the size of lamps specified in 02920.51. Do not wire green arrows into the flashing circuit where used with flashing beacon indications.

Where a flashing yellow lens of 12 inch nominal or greater diameter is to be used as a beacon, provide and install an effective voltage reducer to the lamp circuit that will reduce the voltage level at least 33%, but not more than 50%, of rated voltage when ambient light conditions reach about 0.1 foot-candle.

Mount single-section heads on span wires as shown for three-section heads. Hang heads as nearly plumb as feasible.

(f) Suspension of Signal Heads - Vehicle signals, interior illuminated signs, and reflective signs shall be mounted such that the bottom of the signal backboards and signs shall be not less than 18' above the horizontal projection of crown of the roadway, or as directed by the Project Manager. All heads on any one span shall be mounted such that the bottom of all signals will be at substantially the same elevation. The tops of the signs shall be level with the tops of the adjacent signal backboards. The maximum length of the stem between the plumbizer and the signal head shall be 18" unless otherwise directed. All signals and signs shall be substantially plumb.

All signals and signs mounted on span wires shall be tethered as shown. Signals and signs mounted with plumbizers shall utilize plumbizers with 6 leveling screws.

All bolts, nuts, washers, lock washers and set screws utilized for the suspension of signals and signs shall be Type 316 stainless steel. This particular alloy is non-magnetic and will be tested in the field for this property.

Signals shall be suspended using a tri-stud adapter assembly. On signal suspension assemblies where adjacent parts can be rotated, install a cotter pin to secure the parts as shown on the details. When setscrews are incorporated into the suspension fittings, drill and tap a hole of sufficient size to allow the setscrew to extend into the adjacent part. Where the top bracket enters the signal housing, place a non-hardening silicon caulking compound around the bracket to make a watertight seal.

Nylon insert lock nuts shall be used on bolts and hangers that extend through and are secured inside the signal head housing.

Pedestrian signals shall be mounted on poles using "clamshell" type mounting hardware. The clamshell shall consist of a two piece cast aluminum alloy assembly. The two separate castings shall be joined in the final assembly by the use of stainless steel pins. The pole half of the assembly shall be designed to adapt to a wide range of pole configurations. The pole mating surface shall be configured much like terminal compartments used for conventional bracket mounting.

The clamshell shall be mounted by bolting directly to a tapped metal pole or lag screwing directly to a wood pole. When mounting is on a wood pole the pole half of the clamshell shall have 1/2" threaded holes on each side for external conduit attachment. Plugs shall be furnished and installed in those holes that do not require conduit connections.

The bolt hole shall be elongated from side to side and the recessed shoulder shall be curved to allow rotation of the installed assembly 15° in either direction from center for a total of 30° when mounted on a 4" pole.

The clamshell assembly shall provide a "pole to pedestrian head" clearance of approximately 3 inches.

The head half of the assembly shall be secured to the pedestrian signal with four 5/16" bolts.

The pole mounting half of the clamshell assembly shall be equipped with a conventional terminal compartment type twelve position molded terminal block with each position consisting of a pair of terminals, one on the line side and one on the load side of the block.

Electrical connection of the pedestrian head section of the clamshell mounting assembly shall be through a three conductor cable permanently attached to the pedestrian head section and connected to an appropriate load side position of the terminal block in the pole mounting half of the clamshell assembly. A rainshield shall be provided in the upper third of the pole half to prevent water entrenchment onto the terminal block. A neoprene gasket shall be provided on the mating surface of the two halves of the assembly to provide raintight protection.

Connections to field wiring may be made by conventional screw type terminals or by quick disconnects.

(g) Vehicular Signal Head Covers - Cover mounted vehicle signal heads at all times until the signal installation is ready for continuous operation. Cover the entire face of the signal head to the rim of the backboard with burlap, canvas, black plastic or other approved cover material, except that 10% of each lens may be left visible to facilitate testing.

(h) Audible Pedestrian Signal (APS) - When shown or specified, the APS shall provide a unique sound coincidental with the WALK indication. The APS shall include a solid state electronic board(s), power supply, enclosure, loudspeaker and mounting hardware necessary for fulfilling the intended use stated herein and in applicable portions of Chapter 1 of the September 2001 Standard Specification for Microcomputer Signal Controller.

(1) General - The exterior dimensions of the APS unit shall not exceed 6 inches in height, 4 inches in width, and 6 inches in depth.

The weight of the APS unit shall not exceed 1 pound.

The button actuated delay time shall be adjustable in one-second increments throughout the range of 0 to 15 seconds.

The APS unit shall have a sound inhibit circuit capable of control by an external device.

(2) Electrical Requirements - The APS unit shall operate on 95 to 130 VAC, 60Hz, ≤ 3 W.

Provide a power protection circuit consisting of both fuse and transient protection.
Provide an optically isolated circuit allowing delayed actuation of the audible signal.

(3) Environmental Requirements - The APS unit shall function properly throughout an ambient air temperature range of -35 °F to 165 °F.

(4) Outputs - Provide voice message including automatic repeat capability for messages up to 20 seconds in length.

The audible signal shall be self-adjusting based on ambient noise during the WALK period.

The volume level at a distance of 3 feet from the APS enclosure shall be 66dB typical, with a maximum of 90dB.

The minimum volume level shall be adjustable proportionally from 66dB to 90dB without dismantling the APS unit housing.

Provide two switch-selectable electronic sounds as specified in the following:

Parameter	Sound #1	Sound #2
Sound type	"Peep-peep"	"Cuckoo"
Method	Electronic var. frequency tone	Electronic var. frequency tone
Period	1.0 sec. $\pm$ 20%	1.5 sec. $\pm$ 20%
Duration	0.2 sec. $\pm$ 20%	0.6 sec. $\pm$ 20%
Frequency Base	2800 Hz $\pm$ 20%	1100 Hz $\pm$ 20%
Frequency Deviation	- 800 Hz $\pm$ 20%	+120 Hz $\pm$ 20%

00990.43 Traffic Signal Detection Devices:

(a) Pedestrian Push Buttons - Mount pedestrian push buttons on a pole, pedestal or post whose foundation directly abuts an asphalt concrete or portland cement concrete landing or walkway. Equip push buttons with an instruction sign having an arrow pointing to the crosswalk for which it is intended.

(b) Inductive Loop Detectors:

(1) Saw Cut - Make cuts compatible with construction and in the most practical, direct line between loops and junction boxes, except where parallel to, or nearly parallel to, a lane line; then locate cuts under the lane lines. Make saw cuts at least 1/2 inch wide for loop wire and loop feeder cable. 1/2 inch saw cuts may be made with single blades. For wider cuts, use multiple-blade saws.

Saw cuts shall have smooth bottoms, with no edges due to differences in cut depth.

Saw cuts shall not require greater than a 90° bend in loop wire. Cuts shall not create islands of pavement less than 2 1/2 square feet in area.

Flush cuts thoroughly with a high-pressure water stream immediately after sawing, and before the cuttings dry. Blow free of water, debris, rock, and grit with high-volume or high-pressure air. Slots may also be cleaned by means of a high-pressure water injection/vacuum extraction system.

Dry before placing wire. Remove rocks or other material that may be wedged in the cut.

Any number of loop wires may be installed in a single saw cut, as long as the minimum cover shown is provided (see standard drawings) and adequate pavement depth is available. The Engineer may limit the allowable saw cut depth and width to avoid damage to the pavement.

Do not make saw cuts in a new open-graded AC wearing course. Instead, install loops in the base lift, or in the existing surfacing if it is to be overlaid, and after milling has been completed.

When there is insufficient pavement depth and when shown, construct detector loop pads. Detector loop pads not shown, but required by the Engineer, will be paid for as Extra Work according to Section 00196.

When preformed loops are called for, refer to Standard Drawings for requirements. Preformed loops may be used in lieu of sawn-in loops, if minimum loop cover can be obtained.

Preformed loops installed during the paving operation shall have a minimum cover of 2 inches. Slotting of the underlying surface may be required to obtain this clearance. Replace loops damaged during installation at no additional cost to the City. Fill preformed detector loops and runs to junction boxes with an approved sealant if subjected to high temperatures and compaction of backfill.

Round loops, 6 feet or 5 feet in diameter may be used in 12 foot or wider lanes as an alternate to standard 4-foot diamond vehicle detector loops. Round loops, 5 feet in diameter may be used in lanes less than 12 feet in width as an alternate to standard 4 foot diamond vehicle detector loops. Install according to standard loop installation Specifications, but make the saw cut exiting the loop perpendicular to the loop.

(2) Wire - Use XHHW loop wire conforming to 02921.23(b). Encase loop wire in a polyethylene tube conforming to IMSA Specification No. 51-7.

Place a permanent plastic label on each loop feeder cable with the loop numbers, in indelible ink, as shown on the Loop Detector Wiring Diagram. Place labels within 4 inches of the end of the jacket at each end of the loop feeder cables.

Do not remove the outside jacket and shield of loop feeder cables more than 6 inches from the end, inside the controller cabinet.

(3) Installation - The Engineer will mark or approve the center point location of all loops to be installed. Do not place wire in saw cuts until the Engineer has inspected the cuts.

After the saw cut is cleaned of debris, place the loop wire by pushing it into the slot with a blunt, nonmetallic object. Use care to avoid damaging the insulation.

Use one continuous, unbroken length of loop wire to form a loop of the number of turns required and to reach the loop feeder cable splice point shown or specified. Use one continuous, unbroken length of loop feeder cable from the loop wire splice point to the cabinet. The loop leads shall have minimum of six twists per foot.

After loop wire is placed and before the saw slot is sealed, install loop wire hold-downs (backer rods) made of closed-cell polyurethane. Place 1 inch lengths of the hold-down material along the loop perimeter and all other saw slots containing loop wire 6 inches from loop corners and at maximum centers 12 inch. Hold-downs shall fit snugly in saw slots.

After placing the wire, test before filling the slots with hot-melt sealant. The loop saw cuts shall be completely filled and sealed with 3M detector loop sealant (Oregon formulation), MSI #34271 Detector loop sealant or an approved equal. Install the sealant in slots according to the manufacturer's instructions and recommendations using an approved pressure feed wand system. Pour pot application will not be allowed. Furnish a copy of the manufacturer's specifications including application procedures. The Engineer may order a test run of any application method or material before filling saw cuts. Have a manufacturer's representative present if using a sealant for the first time on a City project.

Sealant shall not protrude above the pavement, nor be more than 1/8 inch below the pavement level after curing. Where cuts are made on a slope and sealant runs or puddles, start at the low end, pour the sealant, and hold it in place with 2 inch duct tape placed on the roadway surface over the cut. If duct tape or other device is used to contain the sealant in the saw cut, remove it on the same day, after the sealant is fully cured.

In order to prevent heat damage to the insulation, do not allow the temperature of the sealant to exceed 410 °F during application. Install hot-melt sealant in layers to prevent damage to wire insulation. Allow each layer to cool before the next layer is installed. Do not use water to accelerate cooling. Do not seal street boxes with sealant that remains soft after setting or cooling. See Standard Drawings.

Sealants that crack or pull away from the saw cuts after curing, at any time within the warranty period, will be rejected. Remove sealant that fails within this period, clean the cuts of debris and reseal with a sealant satisfactory to the Engineer at no additional expense to the [City](#).

There are three options for loop wire access points. Refer to the plans for the option to be used at each location. Do not make loop wire splices in the access point.

Splice loop wires to feeder cable in junction boxes. Connect loop wires to loop feeder cable with a soldered-compression splice. Remove 4" - 6" of feeder cable outer jacket, drain wire and shield. Do not damage the conductor insulation. Offset splices to ensure they do not make contact with each other. Strip feeder and loop conductors back about 1/2 inch. Crimp with seamless, non-insulated butt connector (3M® part #M14BCX or equivalent) of the proper size. Solder the splice with 60/40 rosin-core solder using a soldering iron, gun or flameless soldering torch. Do not use an open flame torch. Sweat the connection to ensure solder fills voids in the splice. Make sure all edges are smooth. Cover the splice with self-sealing shrink tubing (UL 486, 90 °C, 600 V) constructed of homogeneous polyolefin and having an internally applied sealant. Use heat-shrink tubing on individual wire splices and also over the entire cable splice, extending the tubing at least 1 inch beyond the ends of the insulation and/or inner heat-shrink tubing. [Apply silicon sealant before shrinking the heat-shrink tubing.](#)

Solder all loop feeder conductor terminations from field wiring in signal controller cabinets after crimp lugs have been installed. Crimp lugs used for loop wire field terminals may be insulated or uninsulated.

(4) Resistance Testing - The resistance to ground of the loop and loop feeder combinations, tested with a 500 V Megger tester, shall be 200 MΩ or greater when checked both before placing the sealant and after the sealant has set.

(5) Loop Sensitivity - Loops shall be sensitive to bicycles. After installation is complete the Engineer will test each loop with a lightweight bicycle or other approved device. If the bicycle is not detected on the highest amplifier sensitivity setting, replace the detector at no additional expense to the City, and repeat the procedure.

(6) Preformed Vehicle Detection Loops in Existing Pavement – They shall be Never-Fail loop systems model F-38 or approved equal.

To be an approved equal, loops shall be pre-manufactured and designed for routed or saw cut pavement installation. The loops shall have an integral home run that is protected and sealed to the splice point. This "protected" home run shall reach from the loop into the specified splice box.

Loops shall consist of 4 turns of twenty gauge stranded Teflon coated wire. The wire shall meet or exceed Military-MIL-W-16878/4 Type E, 200° C, 600 V specifications. The wire shall be encased in 3/8 inch hydraulic flexible hose that can withstand 1400 psi and the conduit shall be injected full of soft asphalt rubber sealant. To ensure long-term performance, the loops shall contain sealed expansion-contraction joints at the tee junctions protected with 80 CVPC.

Slots in existing pavement shall have residual moisture dried using compressed air. After the loops and home runs are installed, the slot will be completely filled and sealed in three lifts. There shall be a minimum of 2 1/2 inch ultimate cover over the loops and home runs in existing pavement and 1 inch cover in base lift pavement.

(7) Microwave Detector for Activation of Pedestrian Signals – They shall be MS Sedco Model 1400 bi-directional microwave motion sensors equipped with DIP switch adjustable delay timer, sensitivity and range settings or approved equal. A separate 24 volt transformer (SOLA/HEVI-DUTY Model SDN5-24-100P or approved equal) shall be mounted on DIN rail in the rear of the controller cabinet with an eight position terminal strip mounted adjacent to the transformer on the same DIN rail to power the field devices. The device shall be mounted at eleven feet above the pedestrian landing and pointed directly at the appropriate landing area.

(8) Microwave Detector for Crosswalk Occupancy Detection – They shall be MS Sedco Model 1800 bi-directional microwave motion sensors equipped with DIP switch adjustable approach only or bi-directional, sensitivity and range settings or approved equal. A separate 24 volt transformer (SOLA/HEVI-DUTY Model SDN5-24-100P or approved equal) shall be mounted on DIN rail in the rear of the controller cabinet with an eight position terminal strip mounted adjacent to the transformer on the same DIN rail to power the field devices. The device shall be mounted at twelve feet above the adjacent pedestrian landing and pointed to provide coverage of the near half of the appropriate crosswalk.

00990.44 Traffic Control Signs:

(a) General - The type of sign and method of mounting will be as shown or specified. Provide a hanger with span wire mounted signs that will permit both vertical and horizontal adjustments.

(b) Advance Warning Signs - Signs shall conform to applicable portions of Section 00940. Sign message shall be as shown. If called for on the plans, complete the sign with a flashing beacon unit and/or floodlights.

(c) Overhead Interior Illuminated Signs (Fluorescent Tube, Neon Tube or Fiber Optic) - Use signs designed for span wire, bracket, bridge or mast arm mounting and make sign legends as shown or specified.

Drill and tap setscrews used in sign mountings through the first wall of the conduit. The conduit shall extend a minimum of 1/2 inch beyond the setscrew.

(d) Overhead Aluminum Signs - Signs shall use retroreflective sheeting (Type B ASTM Type IX or XI (DG cubed)), and shall conform to the applicable portions of Section 00940.

00990.46 Fire Preemption - Fire preemption systems shall:

- Include all required control modules, detector units, detector feeder cable, wiring harness, interface circuitry and miscellaneous hardware
- Have detector feeder cable of the type and size recommended by the supplier of the preemption equipment
- Have cable that runs continuously without splices from the detector unit to the controller cabinet
- Include City-approved rack-mounted control modules with all Model 170 signal controllers
- Not include emitter units

00990.47 Railroad Interconnect - Where interconnection to railroad circuits is shown or specified, interconnect the traffic signal cabinet and the railroad cabinet. The railroad company will furnish two sets of contacts in the railroad cabinet. The contacts open upon actuation of the track circuit by a train. The interconnect circuit operates as a "fail-safe" device which will cause an actuation if power to the track circuit is interrupted.

Run the circuit conductors in underground electrical conduit of the size shown. Terminate the conduit at the railroad cabinet at the location and in the manner directed by the railroad company. Extend the ends of the wire at least 3 feet beyond the end fitting of the supplied conduit. All other work inside the railroad cabinet is the responsibility of the railroad.

Do not under any circumstance do any work in the immediate vicinity of the railroad cabinet without first notifying the Engineer and receiving permission. The City will obtain supervisory personnel from the railroad company.

Do not place any materials or equipment in the vicinity of the tracks without observing proper clearance. When applicable, clearances will be listed in the Special Provisions under 00170.01(a)(5).

00990.48 Coating:

(a) Signal Heads - Pedestrian signal heads, vehicle signal heads, beacon heads and backboards shall be powder coated inside and outside to meet Federal Standard 595b-37038 (dull black). Powder coating shall consist of 3 mils of primer and 2 mils of moisture-cured polyurethane.

(b) Signal Control Cabinets - Anodize signal control cabinets constructed of aluminum.

(c) Brackets and Hangers - All exposed conduits and fittings including signal mounting hardware shall be galvanized in conformance with AASHTO M 111 and then primed with 3 mil DFT, dry film thickness, of Wasser MC FerroX B and top coated with 3 mil DFT Wasser MC-Luster Topcoat. Apply MC-Luster Topcoat Signal Bronze (W21.0298) in accordance with the manufacturer's recommendations and Steel Structure Painting Council SSPCPA 1 – "Good Painting Practices.")

(d) Interior Illuminated Metallic Sign Cabinets (Fluorescent Tube) - Paint cabinets according to the following:

(1) Inside of Cabinet - Wash all exposed aluminum and steel parts with a metal cleaning solvent. When metal is thoroughly dry, spray on one coat of zinc chromate paint. When dry, finish with two coats of high quality white enamel.

(2) Outside of Cabinet - Apply two coats of aluminum paint to any exposed metal parts, other than aluminum, on the outside of the cabinet.

(3) Handling - Refinish any scratches or abrasions on the finished surface of the cabinet to the Engineer's satisfaction.

(e) Interior Illuminated Metallic Sign Cabinets (Neon Tube) - Paint cabinets according to the following:

(1) Inside of Cabinet - Follow the procedure of (d)(1) above, except after the zinc chromate paint is dry, finish with three coats of a dull, flat, gray or white, weather-resistant paint. Finish the front, exposed face louvers and the tube supports on the inside of the hood with three coats of the same paint.

(2) Outside of Cabinet - Prime the outside of the cabinet and apply two coats of the flat black enamel.

(3) Handling - Same as (d)(3) above.

(f) Fiber-optic Sign Cabinets - Paint cabinets according to the following:

(1) Inside of Cabinet - Do not paint interior surfaces of the cabinet.

(2) Outside of Cabinet - Same as (e)(2) above.

(3) Handling - Same as (d)(3) above.

Finishing

00990.70 Testing and Turn-on - This work consists of testing traffic signal control equipment, testing traffic signal installations, and turning on completed traffic signal installations. Do not conduct turn-ons on Fridays unless approved.

(a) Delivery of Control Equipment - Provide manuals, diagrams and other documents as required by the [City](#). Deliver all traffic signal control equipment, including wiring diagrams and operation manuals, in one shipment. Partial shipments will not be accepted and will be returned, at Contractor's expense, to the Contractor. Include the following information with equipment shipments:

- Contractor
- Supplier
- Manufacturer
- Location
- Contract number
- [City](#) for which the equipment is to be tested. Include a complete set of plans and specifications to which the equipment is to be tested.

Deliver the traffic signal control equipment and information for testing to:

Oregon Department of Transportation
Traffic Signal Services Unit
2445 Liberty St. NE
Salem, Oregon 97303-6738

(b) Control Equipment Testing - The following traffic signal control equipment will be tested by the [ODOT Traffic Signal Services Unit](#) for conformance with the Contract Documents before being installed:

- Controller unit
- Controller cabinet
- Power supplies
- Input devices
- Output devices
- Conflict monitors
- Flasher units
- Relays
- Preemption devices
- Auxiliary equipment in the cabinet
- Other equipment required for the operation of the installation

Control equipment will be tested at [the expense of](#) the Contractor.

The control equipment will be tested in three categories: physical, functional and environmental. ODOT will require six weeks for completion and evaluation of the testing.

(1) Physical Testing - Physical testing of the traffic signal control equipment will consist of an inspection for quality of work and conformance to Contract Documents. The inspection will include:

- All specified equipment, wiring diagrams, operation manuals and documentation supplied
- The overall quality of the equipment and cabinet wiring

(2) Functional Testing - The functional testing of traffic signal control equipment will include checking:

- All specified input and output control functions for proper operation
- For proper operation of all noncontrol devices, such as switches, circuit breakers, outlets, fans and ground fault interrupts (GFIs)

Functional testing will be done at normal temperature and supply voltage, with the control devices set up and connected to a display panel and input simulator.

The controller unit timing and control functions will be programmed, and the inputs adjusted to simulate actual traffic control conditions.

The control devices will be visually observed during the test for proper input, output and control operation.

(3) Environmental Testing - Environmental testing of traffic signal control equipment will include checking the ability of devices to operate as specified, under conditions of variable temperature and power supply voltage.

The control equipment will be set up in an environmental chamber. Testing, monitoring and simulation apparatus will be connected and adjusted. Controller unit timing and control functions will be programmed. The control equipment will be turned on and the operation allowed to stabilize at least 30 minutes before testing.

The initial testing is performed at normal temperature and power supply voltage, and includes the spike test and timing test.

The spike test introduces 300 V AC positive and negative spikes onto the power supply. The equipment is observed for any disruption to normal operation.

The timing test monitors and records the accuracy of controller timing functions, such as minimum green, maximum green, walk, and yellow.

The control equipment will be cycled through temperatures from -30 °F to +165 °F. The control equipment will be required to operate for a maximum of 12 hours at both the high and low temperatures. During operation of the high and low temperature limits the accuracy of the controller unit timing functions will again be monitored and recorded.

The power supply voltage will be varied between 95 V AC and 130 V AC during the temperature test. Standard procedure is to use 95 V AC during the low temperature cycle and 130 V AC during the high temperature cycle.

Following completion of the temperature testing, the control equipment is removed from the environmental chamber, set up and connected to a display panel and input simulator. The control equipment will be required to operate for a maximum of 72 hours at normal temperature and power supply voltage under simulated traffic control conditions. Operation will be visually observed on a random basis during the test.

(c) Control Equipment Failure - A traffic signal control equipment failure is any occurrence that results in nonspecified operation of the equipment.

The Contractor will be notified of all control equipment failures, and shall make on-site repairs within five days of receiving the notification.

Following repair of the control equipment, the testing will be resumed at the beginning of the test category in which the failure occurred.

(d) Control Equipment Rejection - The traffic signal control equipment will be rejected under either of the following conditions:

(1) Twice Fail - The control equipment fails twice in the same testing category.

(2) Failure to Repair - The Contractor fails to repair the control equipment within five days of receiving notification of the failure.

Pick up rejected traffic signal control equipment within 10 days of receiving the rejection notice, or it will be returned, at Contractor's expense, to the Contractor.

Replace with control equipment having a different serial number.

Rejected control equipment will not be accepted for testing or installation on any subsequent traffic signal project within the State of Oregon.

(e) Control Equipment Acceptance - Traffic signal control equipment that successfully passes the testing procedure will be certified by the [ODOT Traffic Signal Services Unit](#) as acceptable for installation. Acceptability for installation does not guaranty final acceptance of the completed installation.

The successful completion of the testing does not relieve the Contractor of the responsibility to furnish a complete working signal installation at the time the equipment is placed in operation.

The Contractor will be notified when the testing has been completed. Pick up the controller cabinet at the test facility.

(f) Control Equipment Installation - Be responsible for pick-up, delivery and installation of the controller cabinet.

Be responsible for picking up the signal equipment after testing, installing the signal equipment and checking the field wiring and control equipment operation prior to turn on of the equipment.

The control equipment shall be kept in a warm and dry location from the time it leaves the State Test Lab. until it arrives at the intersection. The controller cabinet shall not be installed until power is available at the service switch. Immediately after installing the controller cabinet, a 100 watt lamp shall be installed and energized to provide a heat source until the intersection is placed into operation.

(g) Field Testing - Field testing of traffic signal installations will be performed by City electrical crews. Notify the Engineer one week in advance of the anticipated signal completion date. The Engineer will notify the City's Traffic Signal Section and the City's electrical crew of the anticipated completion date. Field testing will be performed within one week following the date of completion. The Engineer will notify the Contractor of the test results. If an intermediate Contract Time is specified for signal work, the Engineer may suspend that portion of the work so that time may be excluded according to 00180.80(d)(1)(e) after the final corrections have been completed, or the signal is turned on.

Information on City testing procedures is available from the Engineer.

(h) Traffic Signal Turn-on - The Engineer will establish the date and time the installation is to be turned on. The City will turn on the signal within one week after completion of corrections.

Be present at the Project Site to assist as necessary.

After traffic signals are turned on and operating as designed, the agency ultimately responsible for maintenance will assume operation and maintenance of the signal. Turn-on does not constitute final approval. The Contractor is still obligated to finish any incomplete portion of the installation and correct problems with workmanship or replace material that does not meet Specifications. After turn-on, damage to the traffic signal installation caused by conditions beyond the Contractor's control will be the responsibility of the City.

(i) Interconnect Cable Testing:

Test each interconnect cable circuit installed in the system. Test the complete system only when all terminations for each cable circuit are completed from the interconnect or controller cabinet at the beginning of the new cable run to the controller or interconnect cabinet at the end of the new cable run. If any test is failed, repair the circuit and repeat the entire test series for that cable circuit.

Perform all tests in the presence of the Engineer. Document the test results. When the tests are completed, whether successful or not, furnish the test results and the test data to the Engineer. Conduct tests, as described below, for all cable conductors, including spares, the cable shield, and all field terminations.

In addition to testing the complete system, perform the following tests for each cable circuit:

(1) Continuity - Perform a continuity measurement for each conductor and the cable shield in the system. Conductor resistance shall not be more than 10 Ω per 1,000 feet for each cable pair and shield of the communications cable. Measure the resistance with an ohmmeter having a minimum input impedance of 10 M Ω /V. Record the resistance of each pair and furnish to the Engineer as described above.

(2) Isolation - Perform an isolation measurement for each conductor and cable shield in the system. Measure the insulation resistance with all connections to the conductor or shield under test removed and all other conductors in the cable grounded. Make the measurement with a DC potential of not less than 360 V nor more than 550 V, continuously applied for one minute. Insulation resistance of each cable conductor and the shield shall exceed 1,000 MΩ per mile. Use a Megger tester with a meter scale for measurements, marked with a range from 100 KΩ to 100 GΩ, and with zero and infinity also marked.

00990.75 Warranty - The warranty of 00170.85(b) and other warranty provisions apply to work done under this Section. A one year warranty applies to all work done and all materials incorporated under this Section. This does not replace or reduce other warranties specified in excess of one year.

Measurement

00990.80 Lump Sum Basis - There will be no measurement for work done under this Section.

Payment

00990.90 General - Payment will be made at the Contract price for the following items:

	Pay Item	Unit of Measurement
(a)	Traffic Signal Installation	Lump Sum
(b)	Traffic Signal Modifications	Lump Sum
(c)	Loop Detectors Installation.....	Lump Sum
(d)	Interconnect System	Lump Sum

Items (a) through (d) include payment for replacement of disturbed earthwork, base and surfacing, when applicable.

Item (a) includes furnishing and installing all items of the traffic signal system, including the fire preemption system, the controller, controller cabinet equipment and programs as applicable, and detection system, and includes removing, salvaging, and stockpiling traffic signal equipment as specified.

Item (b) includes furnishing and replacing or installing items for an existing traffic signal installation as specified and includes removing, salvaging, and stockpiling traffic signal equipment as specified.

Item (c) includes furnishing and installing a complete traffic loop detector installation, including incidental controller equipment for existing traffic signal installations.

Item (d) includes furnishing all items of the interconnect system as specified.

Payment for replacement of solid conductor ground wire with THWN wire according to 00990.40(e)(2)(d) will be considered incidental to the work of this Section, and no extra payment will be made.

Payment for providing railroad company personnel to supervise interconnection with railroad cabinets will be considered incidental to the work of this Section, and no extra payment will be made.

Payment will be payment in full for all materials, equipment, labor, and Incidentals necessary to complete the work as specified.

00990.91 **Incidental Basis** - Where neither the Special Provisions nor bid schedule indicates separate payment for street name, regulatory and other signs installed on traffic signals, perform work as incidental work for which no separate payment will be made.

Section 00996 - Traffic Camera Systems

Description

00996.00 Scope - This work consists of furnishing and installing new traffic cameras, including field equipment such as the camera assembly, pan/tilt units, camera poles, camera power supply, Fiber Distribution Units (including splice trays and coupler plates, Fiber Optic Video/Data Multiplexers, Fiber Optic Data Transceivers, Fiber Optic Communications Node, and all miscellaneous video, data and power cables to equipment between the fiber distribution unit and the camera.

00996.01 Abbreviations:

ANSI	- American National Standards Institute
ASTM	- American Society for Testing and Materials
ATMS	- Advanced Traffic Management System
AWG	- American Wire Gauge
BNC	- Bayonet Neill Concelman
bps	- Bits per second
CCD	- Charge-Coupled Device
CCTV	- Closed Circuit Television
CFR	- Code of Federal Regulations
dB	- Decibel
EIA	- Electronics Industries Association
EPA	- Effective Projected Area
FCC	- Federal Communications Commission
FDU	- Fiber Distribution Unit
FO	- Fiber Optic
FOP	- Fiber optic outside plant cable
Hz	- Hertz
MHz	- Megahertz
NEC	- National Electrical Code
NEMA	- National Electrical Manufacturers Association
nm	- nanometer

NTSC	-	National Television Standards Committee
ODOT	-	Oregon Department of Transportation
OFNP	-	Nonconductive Optical Fiber Plenum Cable
OFNR	-	Nonconductive Optical Fiber Riser Cable
OTDR	-	Optical Time Domain Reflectometer
OSHA	-	Occupational Safety and Health Administration
PCB	-	Printed circuit board
PTZ	-	Pan/Tilt/Zoom
p-p	-	Peak to Peak
PVC	-	Polyvinyl Chloride
REA	-	United States Rural Electrification Administration
RG	-	Radio Grade
SM	-	Single Mode
SMFO	-	Single Mode Fiber Optic
ST	-	Type of Fiber Optic Connector
TIA	-	Telecommunications Industries Association
THWN	-	Moisture and Heat Resistant Thermoplastic with Nylon Jacket Conductor
TMOC	-	Traffic Management Operations Center
UL	-	Underwriter's Laboratory
UPC	-	Ultra Physical Contact
UV	-	Ultraviolet
V	-	Volt, vertical
VAC	-	Volts, Alternating Current
VMS	-	Variable Message Sign
W	-	Watts

00996.02 Definitions:

Camera Pole – A one-piece pole, tenon, anchor bolts and base plate.

Closed Circuit Television Assembly (CCTV) – Camera, lens, environmental enclosure (housing), and necessary connectors and cables.

Connector – A mechanical device used to provide a means for attaching to and decoupling from a transmitter, receiver, or another fiber (such as on a patch panel).

Connector Module Housing (CMH) – Patch panel used in the FDF to terminate single-mode fibers with most common connector types and may include jumper storage shelf and hinged door.

Couplers – Device that mates two fiber optic connectors to facilitate transition of optical light signals from one connector into another. Couplers may also be referred to as: adapters, feed-thrus and barrels and are normally located within FDFs mounted in panels. May also be used un-mounted to join two simplex fiber runs.

Fiber Distribution Frame (FDF) – A rack-mounted system usually installed in the TMOC, and or communications Hub consisting of a standard equipment rack, fiber-routing guides, horizontal jumper troughs, FDUs, CMHs, and SMHs. The FDF serves as “home” for passive fiber optic components from cable breakout for connection by jumpers to the electronics.

Fiber Distribution Unit (FDU) – Enclosure containing both a CMH and SMH.

Integrated System Testing – Testing associated with the functional performance of the system with all subsystems composing the system properly interconnected and powered; testing of the complete system with all elements working together.

Link – A passive section of the systems, the ends of which are to be connected to active components and may include splices and couplers.

Pan/Tilt Unite (PT) – Unit for moving CCTV camera via remote control to view a particular scene.

Patch-cord – A short fiber optic cable with a connector installed on both ends; typically used for connection within an FDF. Patch-cords may also be referred to as jumpers.

Pigtail – Relatively short length of fiber optic cable with a connector on a single end and typically installed in a splice tray of a fiber optic distribution unit.

Power Meter – Portable piece of fiber optic test equipment that, in conjunction with a light source, is used to perform end-to-end attenuation testing. Contains a detector sensitive to light at a designed wavelength of system under test. The display indicates amount of power injected by light source that arrives at receiving end of link.

Video Control System – Interface to system software allowing user input through check boxes, icons, and radio buttons in a graphical manner in a Windows NT format.

00996.03 Required Submittals - Within 30 days after the contract is awarded, submit to the Engineer a complete listing of all major components of the system and operational description for approval. Include the manufacturer's name, model numbers, catalog sheets and/or other descriptive literature of proposed materials. The catalog sheets and literature shall include technical data, physical properties and operational description in sufficient detail to demonstrate the equipment meets these specifications. Submit installation details for the camera cabinet and schematic drawings showing all proposed materials, dimensions, part make, model, and quantity.

00996.04 Quality Assurance - Except as provided below, each electrical product shall be listed for intended use in one of the following:

- Underwriters Laboratory Electrical Appliance and Utilization Equipment Directory
- Underwriters Laboratory Construction Materials Directory

Each product shall bear the listing organization's label. In the absence of a label, provide documentation verifying product listing.

For products not listed in the above directories, provide evidence that the product has been tested and certified by a nationally recognized laboratory, in accordance with 29 CFR 1910.7. The following are acceptable evidence:

- OSHA documentation that demonstrates recognition
- Laboratory documentation that verifies testing in accordance with a recognized national code or standard

00996.05 Regulations, Standards, and Codes - The following documents and others referenced therein form part of the Contract to the extent designated in this Specification.

Code of Federal Regulations (CFR)

Title 29, Part 1910.7	OSHA Recognition Process for Nationally Recognized Testing Laboratories
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Institute of Electrical and Electronics Engineers, Inc. (IEEE)

C62.41 – 1991	Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits
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National Fire Protection Association (NFPA)

70 – 2002	National Electric Code
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Underwriters Laboratories (UL)

Electrical Appliance and Utilization Equipment Directory – 1998

Electrical Construction Equipment Directory – 1998
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50 – 1996	Enclosures for Electrical Equipment
489 – 2002	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
943 – 1993	Standard for Safety for Ground-Fault Circuit Interrupters
1059 – 1993	Terminal Blocks
1449 – 1996	Transient Voltage Surge Suppressers
1778 – 1994	Uninterruptible Power Supply Equipment
1950 – 1995	Safety of Information Technology Equipment, Including Business Equipment

Materials

00996.10 General - Furnish materials meeting the following requirements:

00996.11 Video Cable Video cable is used between the camera housing and the camera enclosure for the NTSC signal. Provide RG-6 coaxial cable, 75 ohms with 18 AWG solid, bare copper center conductor with 95 percent or greater bare copper braided shield. Video cable shall be suitable for wet locations.

See Section 00959 for the specifications of the fiber optic cabling and connectors used for the transmission of video over fiber.

00996.12 Camera Power Cable - Provide one pair of 14 AWG THHN/THWN, copper stranded conductors.

00996.13 Camera Grounding and Bonding - Provide one 8 AWG bonding conductor.

00996.14 Camera, Lens, Housing and Pan/Tilt - The camera, lens, housing, and pan/tilt assembly shall integrate to form a complete functioning system. The minimum performance specifications for the camera and lens are:

Video Signal Type:	NTSC
Image Sensor:	1/4 inch CCD
Pixels:	724 min. Horizontal by 494 Vertical
Horizontal Resolution:	470 TV lines
Lens:	F=4.1~11/16 inch optical minimum
Zoom:	18X optical minimum, 12X digital
Zoom Speed:	5.8 seconds maximum
Horizontal:	47° at 5/32 inch wide zoom
Angle of View:	3° at 11/16 inch minimum telephoto zoom
Focus:	Automatic with manual override
Max. Sensitivity at 35 IRE:	0.08 lux minimum at 1/2 sec shutter
Shutter Speed:	Automatic with manual override 1/2~1/30,000
Iris Control:	Automatic with manual override
Synchronization:	Internal/AC line lock
Signal to Noise Ratio:	Greater than 48 dB
Gain Control:	Automatic/Off
Video Output:	1.0 Vp-p (75 ohms composite)
Video Connector:	BNC bulkhead on rear of camera
White Balance:	Automatic with manual override
Power:	24V AC, 60 Hz (nominal)
Dome Pendant Construction:	316 SST or Steel (painted)
Finish Color:	White
Lower Dome Construction:	Acrylic
Pan Movement:	360° continuous pan rotation
Vertical Tilt:	Unobstructed 2° to -92°
Manual Pan Speed:	0.1 to 80° per second minimum
Preset Pan Speed:	250° per second minimum
Manual Tilt Speed:	Variable, 0.1 to 200 degrees per second
Present Tilt Speed:	200° per second
PTZ Protocol:	Pelco's P&D
Communication:	RS-485
Light Attenuation:	Clear, zero light loss
Cable Entry:	1 1/2 inches (nominal) NPT connection
Operating Temperature:	-49 °F to 122 °F
Effective Projected Area:	1.18 ft ²
Power:	24 VAC, 60 Hz (nominal)
Environmental:	NEMA Type 4X rated, sunshield, fan, and heater included
Interior Pressurization:	Dry nitrogen gas, dual Schraeder valves for purging and pressurization, 8 psi minimum
Listings:	UL, FCC Class B
Alarm Inputs:	4

The Camera Housing and Pan/Tilt assembly shall be Pressurized Pelco's Spectra III™ series.

All system components with printed circuit boards (PCBs) will have conformal coating on the PCBs, with the exception of those inside the pressurized dome.

Equipment to be installed includes:

- CCTV Cameras including dome housing, lens and pan/tilt assembly
- CCTV wiring (video/data/power
- CCTV Camera Power supplies
- Miscellaneous Fiber Optic Cabling (including splicing, pigtails, patch chords and testing)
- Fiber distribution Units (including splice trays and coupler plates)
- Fiber optic Video/Data Multiplexers
- Fiber Optic Transceivers
- Fiber Optic Communications Node
- All miscellaneous video, data and power cables to equipment between fiber distribution units and the camera

All equipment supplied shall interface with existing equipment including IFS Orion Fiber Optic Communication System.

(b) Cable Components - FO cable shall consist of, but not be limited to, the following:

(1) Buffer Tubes - Provide sufficient clearance between fibers and inside of buffer tube to allow for unconstrained expansion of fiber. Fibers shall be loose or suspended within tubes; not adhering to inside of tube. Each buffer tube shall contain 1, 2, 6 or 12 fibers.

Extrude loose buffer tubes from material having a coefficient of friction allowing free movement of fibers. Material shall be tough, abrasion-resistant and provide mechanical and environmental protection of fibers, yet permit safe, intentional "scoring" and breakout, without damaging or degrading the internal fibers.

Buffer tube filling compound shall be homogenous, hydrocarbon-based gel with anti-oxidant additives used to prevent water intrusion and migration. Filling compound shall be non-toxic and safe to exposed skin. It shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, non-hygroscopic and electrically non-conductive. Filling compound shall be free from dirt and foreign matter and shall be readily removable with conventional, nontoxic solvents.

Strand buffer tubes around a central member such that strain on cable jacket does not produce stress on fibers.

Color-code each buffer tube according to Munsell color shades meeting EIA/TIA standards.

(2) Central Member - The central member, which functions as an anti-buckling element, shall be a glass-reinforced, plastic rod with expansion and contraction characteristics similar to optical fibers and buffer tubes. To ensure proper spacing between buffer tubes during stranding, a symmetrical, linear overcoat of polyethylene may be applied to the central member to achieve the optimum diameter.

(3) Filler rods - Use solid, medium- or high-density polyethylene for filler rods. Filler rod diameter shall be same as outer diameter of buffer tubes.

(4) Stranding - Strand completed buffer tubes around over-coated central member using stranding methods, lay lengths and positioning so that cable meets mechanical, environmental and performance specifications. Use polyester binding to hold buffer tubes in place. Apply binding with sufficient tension to secure buffer tubes to central member without crushing. Binding shall be non-hygroscopic, non-wicking, or rendered so by the flooding compound, and dielectric with low shrinkage.

(5) Core and Cable Flooding - Fill cable core interstices with a polyolefin-based compound to prevent water ingress and migration. Use a flooding compound that is homogeneous, non-hygroscopic, electrically non-conductive, and non-nutritive to fungus. Compound shall also be nontoxic, safe to exposed skin, and compatible with all other cable components.

(6) Tensile Strength Member - Strand high-tensile strength aramid yarns and/or fiberglass helically around cable core.

(7) Ripcord - Cable shall contain at least one ripcord under jacket for easy sheath removal.

(8) Outer jacket - Outer jacket shall be free of holes, splits, and blisters and shall be medium- or high-density polyethylene with a minimum jacket thickness of 1/32 inch. Apply jacketing material directly over tensile-strength members and flooding compound. Material shall not adhere to aramid strength material. Use polyethylene containing carbon black to provide ultraviolet light protection and discourage fungal growth.

Mark jacket or sheath with manufacturer's name, the words "Optical Cable", number of fibers, year of manufacture, and sequential measurement markings every meter. Actual length shall be within ± 1 percent of the length marking. Use a color that contrasts with cable jacket for the marking. Print height of marking shall be approximately 7/64 inch.

00996.15 Camera Power Supply - Provide a power supply for the PTZ and camera. The power supply shall provide surge protection for the camera power, video and PTZ control connections. The supply shall convert the incoming 120V AC, 60 Hz to 24V AC output. The entire assembly shall be housed in a NEMA Type 4 rated enclosure and mounted within the camera cabinet.

00996.16 Video Encoder and Ethernet Switch - Each camera cabinet shall come equipped with a MPEG-2 fiber optic video encoder for transmitting video over IP/Ethernet networks. The encoder shall also be capable of transmitting serial data, such as pan-tilt-zoom, over the same network. Built into the same housing shall be a Fast Ethernet network switch.

The encoder/switch shall meet the following minimum requirements:

Video Input:	1V peak to peak (75 ohms), NTSC
Number of Video Inputs:	1
Video Connector:	BNC
Frame Rate:	30 fps
Encoding:	MPEG-2
Resolution:	H: 720, V: 480
Bit Rate:	Variable, up to 10 Mb/s
Video Output	
Physical:	100Base-FX
Connector:	LC
Wavelength:	1310 angstroms
Ethernet Switch	
Physical:	10/100 Base-FX
Number of Switch Ports:	8
Wavelength:	1310 angstroms
Port Types:	LC
Mean Launch Power:	-5 to 0 dBm
Networking Protocols:	Multicast filtering, IEEE 802.1p, IEEE 802.1D, SNMP, HTTP, TCP/IP
Distance:	19.9 miles minimum over single mode fiber
Terminal Server	
Data Types:	RS-232, RS-422, RS-485
Number of Ports:	3
Data Connector:	RJ-45 or DB9
Bit Rate:	Up to 115 kbps
Mounting:	Rack, 19 inches, 1U
Operating Temp Range:	-4 °F to 160 °F
Storage Temp Range:	-22 °F to 160 °F
Relative Humidity:	0 to 95% non-condensing
Power:	12V DC from 120V/12V DC converter

The video encoder shall be Teleste EASI IP Series IPE or approved equivalent.

00996.17 Video Decoder - Provide one rack assembly and four video receivers designed to work with the video encoder specified. Provide covers on all unused rack slots. Provide the video decoders and associated rack equipment to the Project Manager to be installed by others.

The video decoder shall meet the following specifications:

Video Output:	1V peak to peak (75 ohms), NTSC
Bandwidth:	5 Hz – 6.5 MHz
Differential Gain:	Less than 3%
Differential Phase:	Less than 3°
Signal to Noise Ratio:	60 dB minimum at maximum optical loss budget
Receiver Sensitivity:	-30 dB
Data Interface:	RS-232, RS-422, 2 wire RS-485
Data Format:	NRZ, NRZI, Manchester, Bi-phase
Data Rate:	DC-100 kbps (NRZ)
Operating Mode:	Simplex or full duplex
Fiber Wavelength:	1310/1550 angstroms, single mode
Optical Emitter:	Laser diode
Optical Detector:	PIN
Indication:	Input sync presence Transmitted data Received data Optical carrier detect Power
Optical Connector:	ST
Power Connector:	Provided by rack assembly
Data Connector:	Terminal block
Video Connector:	Gold plated BNC
Mounting:	Rack
Mean Time Between Failure:	Greater than 100,000 hours
Operating Temp Range:	-40 °F to 165 °F
Storage Temp Range:	-40 °F to 185 °F
Relative Humidity:	0 to 95% non-condensing
Listing:	UL

00996.18 Uninterruptible Power Supply - A UPS shall be provided for temporary backup, protection against temporary outage (brownouts), voltage regulation, and surge protection of the incoming power.

The UPS shall meet the following specifications:

Line Transient Protection:	UL 1449
Safety Compliance:	UL 1778
Waveshape:	True sine wave
EMC Compliance:	FCC Class B
Voltage (nominal):	120 VAC, 60 Hz
Battery Type:	Sealed, maintenance free
Runtime (full load):	30 minutes
Maximum load:	1300 Watts (minimum)
Backup Receptacles:	5-15R (minimum)
Mounting:	Rack mounted, 19 inches

00996.19 Camera Cabinet - Furnish and install a 334 cabinet shell with fan and CCTV PDA (Power Distribution Assembly) pole mount with a Standard 19 in rack. The cabinet shall be UL 50 Type 3R listed. The cabinet shall consist of Housing #1 and Mounting #1 Cage assemblies as defined in ODOT's Standard Specification for Microcomputer Signal Controller. Provide the housing requirements listed in Section 2 with the exception of the police panel. The cabinet shall house the video transmitter, UPS, Fiber Distribution Panel (see Section 00959) and associated camera equipment. The camera cabinet assembly shall be assembled and listed by a certified UL 508A panel shop or have the final assembly certified by an approved National Recognized Testing Laboratory.

The cabinet shall have dataline surge protection meeting IEEE C62.41 for the Pan/Tilt/Zoom data signals.

All incoming 120V circuits shall terminate on terminal blocks. All terminal blocks shall be UL 1059 listed. For No. 10 AWG conductors or smaller, use sectional, double terminal, barrier type terminal blocks with binder screw terminals. Terminal ampacities shall be equal to or greater than conductor ampacities. For No. 8 AWG conductors or larger, use either one-piece for factory assembled, sectional, barrier type terminal blocks with box lug terminals having a pressure plate between screw and conductor. Use terminals of the correct size for the conductor to be connected.

Bus bars shall be sized to accommodate required connections and shall be amperage rated for use.

Incoming power shall be protected by circuit breakers sized appropriately. All circuit breakers shall be UL 489 listed. All equipment shall be protected by branch circuit breakers.

Construction

00996.40 Installation - Install materials and equipment as shown on the plans, according to these specifications, and in accordance with the manufacturer's instructions.

All cables and wires associated with the camera shall be continuous between the cabinet and the camera unit. No splices shall occur outside the cabinet.

00996.45 Identification and Marking - All cables and wiring between subsystems shall be clearly and permanently labeled. All conductors shall be marked by means of imprinted tubular white or yellow plastic wire markers at termination points within 2 inches of wire terminations. Marker nomenclature shall be visible without moving wires or markers.

00996.46 Nameplates - All major components within the cabinet assemblies shall be identified by a nameplate. The nameplates shall be 5/64 inch thick laminated plastic stock with white surface and black core. Letter height of the inscription shall be 15/64 inch minimum.

00996.47 Covers and Guarding - Provide covers or guarding for live parts of terminations on circuits of 50 V or more to ground.

Finishing and Testing

00996.70 Site Acceptance Testing - Demonstrate the Pan/Tilt/Zoom functionality, camera lowering functionality, and video quality performance for each camera site. Present an acceptance test to the Engineer for approval at least 30 days prior to scheduling the test.

00996.75 Warranty - The warranty of 00170.85(b) applies to work under this Section. Provide manufacturer's warranties or guaranties on all equipment before installing equipment on the project. Such warranties shall recite that they are enforceable by either the Contractor or City. In addition, warrant all work performed by the Contractor under this Section for a period of one year, beginning on the date of final acceptance of such work. This warranty requires repair or replacement of equipment warranted, as necessary to correct any defects or failures, and includes all materials, equipment, tools, labor, and incidentals necessary to complete such repair or replacement.

Measurement

00996.80 Measurement (Lump Sum Basis) - There will be no separate measurement of work done under this Section.

Payment

00996.90 Payment (Lump Sum Basis) - The following items will be paid for at the contractor lump sum amount:

(a) CCTV Cameras - Payment for the bid item "Traffic Camera Installations, Complete", accepted in place, includes all cameras, PTZ units, camera lowering systems, cabling, and associated wiring. Payment will be in full for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

(b) Camera Cabinets - Payment for the bid item "Camera Cabinet Installations, Complete", accepted in place, includes the camera cabinets, UPS, and associated video equipment. Payment will be in full for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

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